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" The Chemical News,

Merton House, Salisbury Square,

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NITRATION OF CELLULOSE IN THE PRESENCE OF PHOSPHORIC ACID.*

By C. K. KRAUZ AND F. J. BLECHTA.

(Institute of Explosives, Technical University of Prague, Czechoslovakia.)

The manufacture of nitrocellulose in practice is generally performed by the action of a nitrating mixture, composed of nitric and sulphuric acids acting on cellulose, as purified cotton waste or wood cellulose. In the case of products the chemical stability of which may be subordinate, as they are required, *i.e.*, for the manufacture of artificial silk, of different sorts of lacquers or celluloid, etc., the process is relatively simple as expensive pulping and prolonged boiling (stabilisation) can usually be omitted. If it be desired, however, to use a given nitrocelluose for the production of explosives, the application of the stabilising operations mentioned above is indispensable.

The problem would be very easy if the technical practice could obtain cheap concentrated nitric acid, and nitration could be effected by this acid alone, and without any addition of dehydrating agents. A simple washing of the nitrated product in cold water would be entirely sufficient to give a stable product. Not possessing the desired quantities of concentrated nitric acid at a low price, however, one is obliged to use a dilute one, and to raise its reactivity by the addition of concentrated sulphuric acid, which, besides its dehydrating influence, causes the formation of mixed nitric-sulphuric esters of cellulose. It is these substances, which cannot be removed either by washing the products in water or by treating them with steam in the presence of dilute soda solution, and which cause the instability of gun-cotton and may lead to its spontaneous explosion.

Therefore, it is evident that the possibility of replacement of sulphuric acid in nitrating mixtures by another dehydrating agent, not causing the formation of such unstable and dangerous substances in nitrocellulose, would mean an excellent simplification of the gun-cotton manufacture.

Already several years before the world-

* With subvention of The Czechoslovak Society for Research and Testing of Materials and Constructions, Institution of Masaryk Academy of Labour.

war, the first named of us was seeking for such a substance, and tried to nitrate the cellulose with dilute nitric acid in the presence of some anhydrous salts, as the sulphates of copper, zinc, calcium, magnesium and sodium, the chlorides of calcium and zinc, sodium acetate, etc. The results of these experiments, however, had no practical significance.

Much more interesting results were attained on nitrating the cellulose with a mixture of syrupy phosphoric acid and concentrated nitric acid. For these experiments the purest medicinal cotton wool was used, and the nitrating mixture prepared by mixing phosphoric acid of 1.75 specific gravity, *i.e.*, about 89 per cent. H_3PO_4, with nitric acid 1.515 specific gravity, *i.e.*, about 99 per cent. HNO_3. Altogether we made 12 informative experiments, as follows :— For the first six the nitrating mixture was prepared by mixing equal parts by weight of both these acids, while for another six nitrations the proportion was 2 parts of H_3PO_4 and 1 part of HNO_3. In each case 10 grams of perfectly dry cotton were weighed off and the operation was carried out in a 1,000 c.c. beaker held in cold water in order to maintain its contents at constant temperature of 20° C. The proportion of acid to cotton was in all cases 1 : 80, the contents of the vessel was stirred from time to time by means of a glass rod and covered with a watch-glass. The time of nitration, at which no abnormal changes were observed, was always fixed for 1 hour. The product was then removed from the liquid, squeezed in a porcelain press and placed in a beaker with cold water to which some drops of alcoholic phenolphthalein solution were added. With stirring, pulverised sodium carbonate in small quantities was then added, until the effervescence had ceased, and a permanent pink colouration of the liquid had been reached. Thereupon the produce was washed perfectly in cold water, squeezed out, dried, first in air and finally in a desiccator. Its percentage of nitrogen and its chemical stability were then found.

Table I.

Expt.	Compn. of nitrating mixt. H_3PO_4	HNO_3	H_2O	% N	Abel test at 100°	Ignition pt. °C.
I.	44.5	49.5	6.0	11.8-12.2	After 20 mins. no decomposition.	181.5-183
II.	59.3	33.0	7.7	11.1-11.5	After 20 mins. no decomposition.	181.8-183

The appearance of the dry products was normal.

The results of these preliminary experiments seemed to indicate that the nitration of cellulose in the presence of phosphoric acid takes place in an advantageous manner yielding products of a very satisfactory stability. This fact, suggested that it would be possible to work out a manufacturing process omitting the expensive and prolonged pulping and boiling of nitrated products, and we decided to study the problem in a more exact degree. Our experiments were interrupted by the outbreak of world-war in 1914, and were only finished after the general calming of relations. They are divided into five groups :—

The influence of—

1. Water in nitrating mixtures;
2. Different proportions of acids in these mixtures;
3. Time of the nitration;
4. Temperature on the nitration; and
5. Phosphoric acid on the stability of products.

I.

Influence of Water in Nitrating Mixtures.

For the nitrating mixtures we used concentrated nitric acid, composed of 96.40 per cent. HNO_3, 2.93 per cent. N_2O_3 and 0.67 per cent. H_2O, and syrupy phosphoric acid, containing 85.40 per cent. H_3PO_4 and 14.60 per cent. H_2O. This phosphoric acid was converted into 100 per cent. H_3PO_4 by adding the calculated amount of phosphorus pentoxide. By mixing these concentrated acids in the proportion 1 : 1 there resulted our almost anhydrous primary nitrating mixture containing 48.20 per cent. HNO_3, 1.46 per cent. N_2O_2, 50.44 per cent. H_3PO_4 and 0.34 per cent. H_2O. By adding to it a calculated amount of distilled water, mixtures of desired degrees of dilution were obtained.

The manner of working these nitrations was similar to the above-mentioned preliminary experiments. The proportion of

cellulose to acids was always 1 :50, the temperature was kept within limits of 1° C., at 20° C., and the time of acting was 1 hour.

Till about 4 per cent. H_2O was in the mixture the course of the process was normal, and similar to nitration with nitric-sulphuric acid. With increasing dilution, however, some gel-formation of the nitrated substance, or even its dissolution was observed, thus, to separate the finished operation it was necessary to pour the mixture into cold water. In all cases of examined concentrations the product was well washed in cold water till neutral, and thereupon boiled with 0.1 per cent. sodium carbonate solution during 1 hour. Then followed again another washing in cold water and drying, first in air and finally in a dessicator. The nitrogen in the dry samples was determined by means of nitrometer.

TABLE II.

Expt.	% Compn. of mixt. H_3PO_4	HNO_3	H_2O	Gr. taken	NO c.c.	°C.	P.	%N
1.	50.00	48.20	0.34	.2608	58.6	19	749	12.93
2.	46.99	48.01	3.56	.2455	51.0	17	749	12.08
3.	43.52	47.60	7.46	.2475	47.0	20	734	10.71
4.	40.96	46.33	11.30	.2775	46.5	20	734	9.44
5.	39.90	45.04	13.69	.3205	46.2	17	740	8.29
6.	38.92	44.05	15.68	.2280	26.8	19	740	6.70
7.	38.40	44.48	16.80	.4330	45.4	18.5	740	5.85
8.	37.87	42.92	17.91	.5210	44.6	16	732	4.87
9.	—	87.20	12.80	.2652	40.6	19	749	8.84

The N_2O_3 in the nitrating acid varied between 1.30 and 1.46 per cent.

The appearance of the products during nitration was normal in the first two cases, in Experiment 3 it was gelatinous and in the last it was entirely dissolved in the mixture. In the other cases it was almost dissolved. The appearance of the products after nitration was only normal in the first case, in the second it was resistant, and in the third the product was dissolved in the nitrating mixture, but was re-precipitated with water mixture. In an all the others the product was amorphous.

These results show that with exception of No. 1, the amount of nitric acid in all examined mixtures was higher than the percentage of phosphoric acid and nevertheless the nitrogen content in the products decreases rapidly with an increasing quantity of water in the mixture, *e.g.*, in experiment 8, where a mixture with about 18 per cent. H_2O was used, a percentage of N of only 4.87 resulted. This becomes still more interesting if one considers that the action of a nitric-sulphuric acid with the same content of water as in No. 8, leads to a nitrocellulose with about 12 per cent. N. As is supposed from our experiments, the phosphoric acid under given conditions of nitrations, not only performs the part of a dehydrating agent, but seems to participate in no reaction at all. This assumption is largely proved by the results in Experiment 9, where the nitration under the same conditions was made by means of nitric acid diluted with 12.80 per cent. of water only. Similarly as in case of Experiments 4 and 5, the cotton was dissolved completely in the liquid and after pouring into cold water an amorphous nitrocellulose with 8.84 per cent. nitrogen, separated. This is in surprising accordance with the value of the arithmetical interpolation of the results 4 and 5, *i.e.*, at 12.49 per cent. H_2O in the mixture, 8.86 per cent. nitrogen in the product.

Considering the relations that occur in nitrating cellulose in the presence of sulphuric acid, and where undesirable sulphuric esters of nitrocellulose are formed, we expected the same phenomena with phosphoric acid. Although phosphoric esters of cellulose are unknown, some remarks concerning the action of phosphoric acid on cellulose may be found in *Schwalbe*[1], *e.g.*, German patents 72,572 and 82,857 of Langhans, proposing the application of cellulose solutions in phosphoric acid for the manufacture of artificial silk. Supposing a similar action as with sulphuric acid, we cannot exclude the possibility of the existence of mixed nitric-phosphoric esters of cellulose. In spite of the results of the chemical stability tests of our nitrocelluloses, which are given later, and

in no way prove the existence of such esters, we tried to perform the direct proof by the following analytical experiments.

We prepared a larger quantity of nitrocellulose from 30 gr. dry medicinal cotton with 1,500 gr. nitrating mixture of the composition in Experiment 1, Table II. The product was then washed with a little cold water and divided into three parts. The *first part* was washed 24 hours in running cold water only, while the *second part* was washed till neutral, and then boiled during 1 hour in 0.1 per cent. sodium carbonate solution and washed again in cold water. The *third part* of the product was washed in cold water till neutral, then boiled with pure water for two hours and finally washed in cold water. All three samples were squeezed out, air-dried and finished in a dessicator and analysed. The percentage of nitrogen, determined by Lunge's nitrometer, was in all three cases practically the same, *i.e.*, 13.06, 12.98 and 13.01 per cent. N. For the phosphoric acid content, 5 gr. in each case was decomposed by boiling with concentrated sulphuric acid, diluted, mixed with nitric acid and fresh ammonium molybdate. After standing 24 hours in the first case only a very minute amount of yellowish sediment was observed while in both other cases the solutions remained perfectly clear. *By these experiments it is seen that phosphoric acid does not affect the nitrating process of cellulose.*

In order to examine how complete the nitration was, we tried to dissolve the different products in acetone. Samples 1, 2 and 3 were completely soluble whereas those from experiments 4 to 8 were dissolved either partly only, or not at all. Because of such solubility results we gave up the determination of viscosity which we originally intended to perform.

[1] C. G. SCHWALBE, *Die Chemie der Cellulose*, page 67.

(*To be Concluded Next Week.*)

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Ninety-eighth General Meeting, at the House of the Royal Society of Arts, John Street, Adelphi, London, W.C.2.

On Tuesday, January 11, 1927, at 5.30 p.m., the following paper will be read :—" The Conditions Governing the Occurrence of Oil in Burma," by Dr. L. Dudley Stamp, B.A., A.K.C., F.G.S., F.R.G.S., A.M.Inst.P.T.

THE PREPARATION OF α-NAPHTHYL-THIOCARBIMIDE FROM α-NAPHTHYL-AMINE AND THIOCARBONYL CHLORIDE.

By G. M. DYSON, B.A., B.Sc., Ph.D., A.I.C., AND
R. F. HUNTER, M.Sc., Ph.D., D.I.C., A.R.C.S.

Hofman's method of preparing α-naphthylthiocarbimide by the acid hydrolysis of s-di-α-naphthylthiocarbamide (*Annalen*, 1846, LVII., 256) is wasteful both in time and material, and the preparation of this thiocarbimide from s-di-α-naphthylthiocarbamide by treatment with acetic anhydride (Werner, *J. Chem. Soc.*, 1891, LIX., 396; Hunter, this Journal, 1925, CXXX., 370; Hunter and Soyka, *J. Chem. Soc.*, 1926, CXXIX., 2961), usually gives yields of the substance varying between 10 and 20 per cent. In view of this difficulty in preparation, it occured to us that the substance might conveniently be prepared by the reaction by which we have synthesised numerous thiocarbimides (Dyson and Hunter, *J. Soc. Chem. Ind.*, 1926, XLV., 81 T; *Rec. trav. chim.*, 1926, XLV., 421), namely, by the action of thiocarbonyl chloride on α-naphthylamine when the formation of the thiocarbamic chloride, which in the presence of water would be immediately decomposed into the mustard oil and hydrogen chloride, might be expected to take place.

$$C_{10}H_7NH_2+CSCl_2=C_{10}H_7NHCSCl+HCl \quad (a)$$

$$C_{10}H_7NHCSCl \xrightarrow[H_2O]{} C_{10}H_7NCS+HCl \quad (b)$$

Actually, we have found that an 80-90 per cent. yield of the required naphthylthiocarbimide is readily obtained under the conditions described in this paper, in a condition of purity approaching 100 per cent.

The thiocarbimide obtained in this way was characterised by its methylthiocarbamide and thiocarbamide derivatives, which are readily obtained in the form of beautifully crystalline solids by treatment of the mustard oil with methylamine and ammonia in alcoholic solution.

EXPERIMENTAL.

α-Naphthylthiocarbimide. Thiocarbonyl chloride (1 mol.) was suspended in eight times its volume of water and vigorously stirred by mechanical means, and α-naphthylamine (1 mol.) in chloroform was run into the suspension. The rate of addition

being such that 10 gms. of amine were added in 5 minutes. After the addition of the amine, the stirring was continued for ten minutes, and the chloroform layer removed and dried with calcium chloride. The chloroform was removed on a water bath and the residue steam distilled in a current of steam superheated to 140°. The thiocarbimide was recrystallised from 60% alcohol, when it formed long silky needles having an odour faintly reminiscent of α-naphthylamine m.p. 59° (Cosiner, *Ber*, 1881, 14, 59). Yield : 80-90 per cent.

α-*Naphthylthiocarbamide* was obtained by treatment of the thiocarbimide with alcoholic ammonia and crystallised from absolute alcohol in glistening prisms m.p. 195°.

s-α-*Naphthylmethylthiocarbamide* was prepared by treating the thiocarbimide in alcohol with 20 per cent. of a 33 per cent. solution of methylamine in alcohol (Dyson and Hunter, *Rec. trav. chim.*, 1926, XLV., 422), and crystallised from alcohol in glistening plates having a pale yellow tinge and melting at 196°.

Imperial College,
London, S.W.7.

General Notes.

CHEMICAL COMBINE TO EXHIBIT.

Features of the British Industries Fair Display.

Imperial Chemical Industries Limited is to hold its first exhibition of products at the British Industries Fair, White City, Shepherds Bush, in February. The display, which will include heavy chemicals, dyestuffs and intermediates, will occupy the centre space, originally reserved for one of the constituent companies, in the section of the Fair which has been organised by the Association of British Chemical Manufacturers.

Other exhibitors in this section will show harmless colours for foodstuffs in conformity with the regulations which came into force in the New Year; a new quality ether which eliminates unpleasant after-effects; insulin from a British plant which has a capacity of over 1,000,000 doses a month (a product yet unmanufactured in Germany); and photographic materials.

A feature of the section will be the increased ranges of the products of all firms. One firm which was making only 5 fine chemicals in 1914, is now making about 240.

PETROLEUM AND NATURAL GAS.

Interest in the search for oil in the province has been quickened by the developments in Alberta. Drilling has been carried on during the year in the Mafeking area, south-west of Treherne, and near Grandview. The results of several years of search have not been very encouraging; they have indicated, however, that drilling should be concentrated on those areas where the Niobrara oil shales are buried to some dephth, and that search should not continue to any great dephth below the Dakota sandstone horizon. Gas is now being used, in small scale, in three areas; in the Waskada district, Treherne and Hartney, the latter two on the north-east flank of the Pembina hills. Gas has recenly been obtained south of Souris.

CANADA'S OUTPUT OF NATURAL GAS ROSE IN 1925.

There was an increase of nearly 14 per cent., in quantity and over 19 per cent. in value in the output of natural gas in Canada in 1925 as compared with 1924, according to finally revised statistics just issued by the Dominion Bureau of Statistics. Production in 1925 totalled 16,902,897 thousand cubic feet at $6,833,0005, compared with 14,881,336 thousand subic feet with a valuation of $5,708,636 in 1924. The quantity of natural gas produced in 1925 was considerably in excess of the total for any preceding year. For the first time Ontario was supplanted as the leading producer by the recently developed fields of Alberta. Alberta production was 9,119,500 thousand cubic feet; Ontario, 7,143,962 thousand cubic feet; and New Brunswick 639,235 thousand cubic feet.

Capital employed by the 161 operating firms in Canada during 1925 was $48,894,802. Employment was furnished 1,059 employees whose total earnings were $1,206,875. There were 2,236 natural gas wells in operation in Canada during 1925; the number in New Brunswick was 32; in Ontario, 2,117; in Manitoba, 1; and in Alberta, 86.

SODIUM SULPHATE IN WESTERN CANADA.

The search for potash during the years of the Great War led to the staking of claims on many of the " alkali lakes " and sloughs which occur in numerous localities in the morainic areas of the prairies, as well as in British Columbia, in the hope that potash or other valuable salts would be found in commercial quantities. Although the search for potash, up to the present, has been disappointing, the prospecting of these areas has demonstrated that Canada possesses large reserves of sodium compounds, principally in the form of sulphates, carbonates and chlorides.

NEW USE FOR ASBESTOS WASTE.

A new use appears to have been found for the millions of tons of waste material produced at the asbestos mines. An engineer, Mr. P. C. Armstrong, on a casual visit to Thetford Mines, observed unusual phenomena in the growth of plants in the area on which dust from the mills grinding asbestos fell. On investigation by the Milton Hersey Company, and by Macdonald Agricultural College at Ste. Anne de Bellevue, it has been ascertained that the dust produced in the milling of asbestos has a distinct effect on certain types of vegetation and certain soils. It corrects soil acidity, which is a serious limiting factor in certain soils of Eastern Canada.

There is said to be 50,000,000 tons of asbestos waste now on the dumps and it is accumulating at the rate of 1,000,000 tons per year. Macdonald College has undertaken further investigations, and Mr. Armstrong, on behalf of the Asbestos Corporation of Canada, is making a further study of the possibilities of rendering this material available for agricultural use.

SUCCESS TO BE REWARDED WITH A LUNCHEON.

Sir Philip Cunliffe-Lister, M.P., President of the Board of Trade, and officials of the Department of Overseas Trade, are to be the guests of the joint advisory committee of exhibitors in the British Industries Fair, London and Birmingham, at a luncheon at the Savoy Hotel on Wednesday, January 19, when they will be thanked for having organised a much bigger and more representative display than the Fair of 1926. The chairman is to be Mr. Walter Lines, representing the London section of exhibitors, and the vice-chairman Mr. P. R. Martin, Birmingham.

ELECTRICAL EQUIPMENT AT MINES.

The report of Mr. J. A. B. Horsley, H.M. Electrical Inspector of Mines, for 1925, which has just been published, contains much of interest to all electricians, managers, and others concerned with electrical equipment at mines. Progress at mines under the Coal Mines Acts is analysed in detail. The total horse-power of motors was 74,000 i.h.p. greater in 1925 than 1924, and over 58 per cent. of the mines at work now use electricity as compared with 52 per cent. in 1921.

In regard to coal cutting machines, electrical types are more than holding their own with compressed air types. During the past ten years, in which the total number of machines of all types in use has nearly doubled, the proportion of electrical machines has increased from 67 to 70 per cent. In this connection the Inspector observes that the extent to which electricity is used for coal cutting varies greatly as between the different coalfields, and he divides the whole country into three well-defined categories :— Scotland, almost wholly electrical; England, excluding Lancashire, half " electrical,(" and half " compressed air "; South Wales and Lancashire, less than one-fifth of machine-got coal obtained electrically.

GLYCERINE FOR U.S.A.

His Majesty's Consul-General at New York (Sir H. Gloster Armstrong, K.B.E.), reports that a local firm desires to be put in touch with United Kingdom exporters of chemically pure glycerine.

Firms in a position to offer such glycerine of United Kingdom manufacture can obtain the name of the enquirers upon application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

NOTE ON WORLD MAP ILLUSTRATING IMPERIAL CHEMICAL INDUSTRIES, LIMITED.

A map of the world has been issued which illustrates the operations of the above Company throughout the world. The map shews clearly that the ramifications of Im-

perial Chemical Industries, Ltd., extend to virtually every corner of the globe, and it is therefore impossible to give a minutely detailed account of them here. The Company's activities throughout the continent of Europe are very extensive, there being offices, agencies or factories in most of the commercially important continental towns. It will be noticed also that the Company's interests in the Far East are very strongly represented—interests which are very sound and prosperous, despite the present unrest in that part of the world. Large business is done also in the main Indian sea-ports, while in South Africa the explosives industry has a very firm hold. The Company is establishing itself strongly in Canada and the United States, while a good trade is done in South America. There are large factories and agencies in Australia and New Zealand, and it is evident that the widespread operations of this great British company constitute a strong bond of union between the Mother Country and other units of the great British Commonwealh of Nations.

33,000 INVENTIONS IN 1926.

Improved Industrial Outlook.

By a coincidence, the figures of Patent Applications in H.M. Patent Office for this year are almost identical with those of last year, and this is especially satisfactory in view of the great industrial difficulties consequent upon both the General Strike and the prolonged Miner's Strike.

Messrs. Rayner & Co., the well-known London Patent Agents inform us that Inventions and improvements relating to "Chemicals and apparatus therefor," have been well maintained, as our readers will appreciate from the contributions regularly appearing in our columns.

As to the proportion of foreign and British inventors, it is regrettable to notice that the preponderance is greatly in favour of the foreigner, more especially the U.S. American, and the German, and it beholds those who are concerned with British Industry to see that our inventors are encouraged, or we shall be left behind in the race for predominance in the world's inventions.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The following paper was read at the meeting held on Tuesday, November 9 :—

Oil Fuel and Other Fuels from Carbonisation Processes. By F. Mollwo Perkin, C.B.E., Ph.D., F.I.C., F.C.S. (Member).

The subject of this paper is one bristling with difficulties. For many years past and particularly of late the technical Press and also the non-technical Press, namely, the newspapers, have been crowded with articles on the carbonisation of coal and other carbonaceous minerals for the production of smokeless fuel, oil and by-products such as sulphate of ammonia.

Unfortunately there has been much exaggeration, and promises have been held out which could never mature. Processes which were unworkable have been boosted, the working expenses have been underrated and from small experimental plant inferences have been drawn which were quite unwarrantable.

It is quite natural for an inventor to believe that his particular process will revolutionise the industry and to want to rush ahead and put up large commercial units. This is the more understandable when one bears in mind the fact that most of the inventors are not blessed with much capital, and after carrying out a large series of experiments find that without outside financial assistance they cannot carry on.

That the problem will be solved, and I believe shortly, is certain. At the same time the inherent difficulties must not be minimised.

It is a long time since the inception of the coal gas industry, but there has been a steady development since the time when the Earl of Dundonald distilled small quantities of coal, filled pigskins with the gas and lighted his way home by burning the gas.

The original gas undertakings worked at quite moderate temperatures, since they used iron retorts. Then came the fire-clay retorts of the horizontal type, then inclined retorts and vertical continuous retorts working at fluctuating temperatures of from 1100° C. to 1400° C.

Of course the advent of the incandescent lamp was a godsend in that gas of much lower calorific value could be used and employed with much better illuminating effects

than the old bat's-wing burners when 20 or 24 candle-power was used. This means, of course, that much more efficient scrubbing can be used and the recovery of the lighter fractions from the gas increased. At the same time the volume produced is larger. I do not intend, however, to discuss in this paper modern gas practice except to draw the attention of those interested in low temperature carbonisation that they can learn much from the plodding work of those engaged in the gas enterprises and realise that the great gas undertakings were built up step by step.

In carbonising coal for the production of smokeless fuel and oil a good coal must be employed if the process is to be an economic success. If the fuel is very high in ash then naturally the heating value is lower than when there is very little ash present, and it does not ignite so readily—consequently its value is lower. Furthermore, if it is high in ash and deficient in volatile matter the oil yield is low and also the yield of gas. The matter is of considerable importance because the gas is required for heating the retorts.

Here I might again make a remark. There has a great deal recently been written in the Press about the yields of gas by low temperature carbonisation and either the enriching or adding to the volume of gas obtained from the gas works. Enriching certainly if you can spare the gas, but the retorts must either be heated by solid fuel or by the gas produced in the carbonising process. The important economic question arises, Which is the cheaper? We know that in gas works about one-third of the coke produced is required to heat the retorts. This brings out again the radical difference between gas works procedure and that of low temperature carbonisation. The first aims at gas; everything else is a by-product. With low temperature carbonisation smokeless fuel is the main product, everything else is a by-product. It follows, therefore, that the smokeless fuel must not be used for heating the retorts. If sufficient gas is not obtained from the low temperature retorts, an outside producer must be employed to give the extra gas necessary. As a matter of fact the yield of gas on the low lemperature plant is from 5300 to 6000 c.f., and there is only a smal lresidue left, if any, after the retorts have been operated.

It is not possible in the scope of this paper to discuss all the processes which have been engaged for low temperature carbonisation. Briefly, however, they may be classified as follows :—

(1) Vertical retorts with no mechanical internal machinery;

(2) Horizontal retorts with mechanical screws or conveyors;

(3) Rotary retorts.

Vertical Retorts.—The Scottish Shale Oil must, I think, be taken as the pioneer of vertical retorts. It was invented by Dr. James Young in 1847 and continually improved until the present-day retorts due to Beilby and Bryson were standardised. One of the main objects was not only to obtain oil from shale, but also a large yield of sulphate of ammonia. To this end the retorts were gradually altered, large quantities of steam were injected, and the oil mainly driven off by this means. The waste gases are still employed for external heating. The object of steam injection is to drive off the oil before the shale drops into the hottest part of the retort and thus prevent the oil cracking.

The gas industry, after having been working for over one hundred years, has not found it practical or economical to build huge retorts in single units. Batteries with 4½ton units are about the maximum and in most cases smaller units are employed.

It can hardly be claimed that so far low temperature carbonisation of coal has been a commercial success. I believe, however, there is no reason to doubt that in the near future a very large amount of coal will be carbonised for the production of smokeless coal fuel and by-products.

My own opinion is that the retort of the future will be vertical, heated externally, and also internally, by passing a portion of the thoroughly scrubbed gas up through the retort. The gas becomes heated by passing through the carbonised material at the bottom of the retort. This helps to cool the coke and the heat taken up by the gas will assist in the carbonisation of the coal as it descends and also carry off the volatile matter more rapidly, thus preventing the oils condensing on the cold material at the top of the retort and being decomposed.

The following figures, I think, will show the possibilities of low temperature carbonisation. The prices are more or less hypothetical and have only been taken as a basis for calculation. For example, although it would not be possible to obtain coal at £1 per ton at the present time, the selling price of the smokeless fuel would be much higher than £2 per ton.

HUTTON COAL—THROUGH AT BATTERSEA.

Analysis of Coal.

Total volatile	30.75
Moisture	2.25

Results on dried.

Volatile	29.15
Ash	9.35
Fixed carbon	61.50

When carbonised this gives a yield of 74½ tons smokeless fuel. 100 tons of coal carbonised would give the following results :

Smokeless fuel	74¼	tons
Sulphate of ammonia	593	lbs.
Motor spirit	279	gallons
Kerosine	205	gallons
Fuel oil	1399	gallons
Pitch	1	ton

	£	s.	d.
100 tons of coal at, say, £1 per ton	100	0	0
74¼ tons smokeless fuel at £2	148	10	0
593 lbs. sulphate of ammonia at 1d.	2	9	5
279 gallons motor spirit (less 10% for purification) + 251 gallons at 1s.	12	11	0
205 gallons kerosine (less 10% for purification) + 184½ gallons at 8d.	6	3	0
1399 gallons fuel oil at 4d.	23	6	0
Pitch at £2	2	0	0
	£194	19	5

Less 30 per cent. ... £136 9 5

Leaving approximately 36½ per cent. net profit.

Grassmore coal left 37 per cent. profit.; and Kent coal approximately 30 per cent.

SOCIETY OF GLASS TECHNOLOGY.

The President, Mr. Walter Butterworth, Senr., M.A., presided at a meeting of the Society of Glass Technology, held in University College, London, on Wednesday, December 15, 1926. Five papers were presented :—

Further Note on Sillimanite as a Glass Works Refractory. By PROF. W. E. S. TURNER, D.Sc.

A pot ring made from a mixture of 5 parts of fine, 1 part of medium, and 1 part of coarse sillimanite,with 3 parts of ball clay, was broken in use after doing service for ten weeks in a pot melting a potash-lead oxide-silica glass. The ring showed little sign of attack by the glass.

A sillimanite pot, holding 30 pounds of glass, had been in use, in the Department of Glass Technology at Sheffield, for melting a series of soda-ferric oxide-silica glasses. The pot stood up well under this work, exhibiting no signs of honey-combing. This result was rather remarkable, since sillimanite usually offered little resistance to the attack of ash rich in iron compounds.

Photographs were exhibited of another pot which had been used for 23 successive meltings and had ultimately a porosity of 14 to 15 per cent.

In order to prove the great resistance offered by sillimanite to changes in temperature, photographs were shown of a pot which was allowed to cool in the bottom of a furnace. After some days the furnace was heated again. The pot was still being used for glass melting a month afterwards, the temperature of the last run in it being 1450°.

Some Corrosion and Erosion Phenomena and Their Bearing on the Macrostructure of Refractories. By J. F. HYSLOP, R. GUMM AND H. BIGGS.

The importance of the macrostructure of refractories was emphasised in connection with corrosion and erosion phenomena. The use of an indirect method, such as that employed, indicated that the characteristics and grading of grog were factors of considerable moment.

Data were given which showed that the disintegration in a solvent of a composite material, such as wax loaded with burnt clay particles, depended on two factors, these being :—

(a) The density of the solute-rich layer relative to the solvent;

(b) The size of the particles.

If a light upward flowing layer was formed the material with large particles would be more rapidly broken up than that containing small particles. The reverse holds if a dense downward flowing layer is formed, the finer the particles the more rapid being the corrosion.

Laboratory experiments on clay rods immersed in chosen glasses confirmed the above statements in respect to the corrosion of clay by glass. In a lead glass the clay with the larger grog was more corroded than that with the finer, but in a soda-lime glass the finer material was the more attacked. Consistent with safety in other directions, the evidence indicated that a refractory meant to withstand corrosion by a lead glass should contain as large a fraction of fine grog as possible, whereas one for use with a soda-lime glass, say, should contain the maximum of large grog.

It was also shown that where erosion was the principle factor in the break-up of the refractory the conditions demanded different characteristics in the grog in that the material must hold the maximum of fine particles.

A Note on the X-ray Patterns of Mullite and Sillimanite. By J. F. Hyslop and H. P. Rooksby.

In two former notes it was stated that sillimanite and mullite gave X-ray patterns which could be distinguished, and the object of this further note was to record the data which had been obtained for several alumina-silica materials. By paying attention to the necessary technique, such as the degree of fineness of the powder and the time of exposure to the beam of X-rays, consistent results were obtained. It was concluded that there were, on close inspection, real and ocnsistent differences between the patterns of sillimanite and of the crystalline substance formed in the samples examined. Further, these differences, although small, had been found sufficient for identification purposes, since they depended upon the relative spacing of the lines and not on differences in intensity which could be caused by preferential orientation of the crystals.

Note on the Design of Parison Moulds. By S. English, D.Sc.

Of the three moulds, the ring, parison and blow moulds ordinarily used in the making of bottles by machines, the parison mould was by far the most difficult to design properly. There was only one feature of a parison mould that could be determined even approximately by a study of the finished bottle it was desired to reproduce, and that was its internal size or glass holding capacity, but even in this respect allowance had to be made for the preliminary blow up which varied from one machine to another, and from one type of bottle to another. For the purpose of parison mould calculations it was convenient to use the volume occupied by 1 ounce of hot glass. Assuming that 1 ounce of glass at 1250° C. occupied three-quarters of a cubic inch, a gob of glass to form a 24 ounce bottle should have a volume of 18 cubic inches. In regard to the shape of parison moulds, the only feature which was recognised as essential, was the absence of sharp corners. The inner surfaces should always be continuous smooth curves.

The primary function of parison moulds was to give a preliminary shaping to a quantity of glass, and the moulds could only do this efficiently by cooling the glass surface in contact with the mould. It had been found that a heavy-walled mould always kept cooler than a light-walled mould under similar conditions. The thicker mould required less external cooling, and retained its good condition longer than the thinner one; but it was much heavier and in the case of a charge of moulds it heated up to the proper temperature so slowly that a considerable loss of output was entailed. Cast iron appeared to be perfectly satisfactory as a parison-mould material. It was suggested, however, that stainless steel parison moulds might be tried in the case of small bottles.

The fifth paper was presented by Mr. V. H. Stott, M.Sc., and was entitled "The Viscous Properties of Glass."

Owing to lack of time the reading of the sixth paper on the agenda was postponed, namely, "The Effect of Cullet on the Melting of Glass," by Prof. W. E. S. Turner, D.Sc.

INSTITUTION OF MINING AND METALLURGY.

Data on the Use of Explosives in Mining. By William Cullen, Member, and J. H. Ronaldson, Member.

We have been induced to contribute this paper in the hope that data regarding the consumption of explosives in mining operations under various conditions, may be of interest and use.

It will be observed that throughout these records the blasting has been mostly done by means of ordinary safety fuse and ordinary detonators. In a few only of the shaft-sinking operations the 'initiation' has been done electrically either by the electric detonators alone—a practice which cannot be generally recommended—or by what is

called 'delay-action fuse' in conjunction with ordinary detonators. The latter practice is now largely followed in the British Isles, but, strange to say, on the Rand, where so many shaft-sinking records have been made, the ordinary safety fuse combined with the ordinary detonator still holds the field.

The delay-action fuse or electric time fuse, as it is sometimes called, is undoubtedly coming into very general use in this country, on the Continent, and in America. It is simply ordinary time fuse which is ignited electrically and is employed with an ordinary detonator.

The electric detonators, on the other hand, are themselves ignited electrically. Of these there are two types, designated respectively low-tension and high-tension. In the former, the ignition is caused by the passage of an electric current through a thin metallic wire which is raised to an incandescent heat. This ignites a pill of semi-explosive material, which in turn sets off the detonator. This pill is generally called the fuse head.

In high-tension detonators, ignition is effected by a high-tension current jumping the gap between the ends of two wires within the detonators. Ignition is thus caused by a spark. These detonators are not used for general mining operations, and, broadly speaking, their use is confined to collieries where only one shot must be fired at a time.

The use of delay-action fuse is, as already indicated, practically confined to shaft-sinking, and the procedure generally adopted is comewhat as follows. The cut, consisting of three shots to six shots, is brought away by low-tension detonation. If this has 'come' satisfactorily, the rest of the holes are charged up, those nearest to the cut having short fuse lengths, those further away longer lengths, and those round the periphery of the shaft bottom still longer lengths. A wide range of lengths of fuse can be obtained in this country, but in America we understand that only three lengths are marketed, and this range may be considered enough for most purposes.

With regard to the detonators themselves, it would appear that the so-called 'azide aluminium detonator' is now used to a considerable extent on the Rand. It is claimed for it that it has a higher 'boosting' effect, and it may be so, but no claim, so far as we know, has been made that it reduces explosive consumption, the consideration of which is the main object of this paper. Aluminium must be used as the container for the detonating composition instead of the old-fashioned copper, for the reason that the detonating composition acts chemically on copper but has no action on aluminium.

It will be observed that in most cases No. 6 detonators are employed, and this is now standard practice throughout the world, but where an explosive is inherently insensitive, the use of a stronger detonator, such as No. 7 or No. 8 does largely remedy this defect. We do not know the particular reasons which determined the use of the large detonators, but some managers assert that over a period they get better results with No. 8 than with No. 6 detonators and prefer to use them, although the cost is nearly double that of No. 6.

Speaking broadly, the cost of explosives is not one of the major mining costs. In the case of coal it works out at a little less than 2d. per ton (inclusive of fuse and detonators) for the whole of Great Britain, and this figure includes shaft-sinking development, ripping, etc. The figures for other countries are not very different. In quarrying or opencast mining, upon which we propose to give a separate paper at a future date, the figures are comparable with those of coal. They are, as might be expected, much higher in metalliferous mining.

Throughout the Empire, with the possible exception of Canada where U.S.A. practice largely obtains, only explosives of the gelatine type are employed in metalliferous mining. There are many reasons for this, among which the following may be mentioned. As a class, they withstand severe climatic conditions better than any other; they do not readily deteriorate; they can be used in either wet or dry holes with equal ease, though certain recognised precautions have to be taken in very wet holes. But their great superiority over all other explosives lies in the fact that they have a high specific gravity—generally round about 1.5 taking water as unity. Most other explosives which have a powdery consistency, for instance American dynamites, ammonal, abelite and liquid oxygen, have specific gravities ranging between 1.0 and 1.2. It is evident than an explosive of high specific gravity charged in a hole has a greater potential power per unit volume of borehole than one with a lower specific gravity, and it is, therefore, of little use to speak of the

relative strengths of various explosives unless regard be had to their specific gravities. After all, the cost of drilling a hole when account is taken of power absorbed, repairs to drills, drill-sharpening, etc., is in most cases much higher than the cost of the explosives charged. The mining man, when he speaks of the strength of an explosive, generally means the strength of equal weights, whereas he should have in his mind the strength of equal volumes.

Gelatinous explosives, without exception, are based on nitroglycerine. Blasting gelatine, for instance, has an approximate composition of 92 per cent. of nitro-glycerine, with 8 per cent. of nitro-cellulose. Gelatine dynamite has about 74 per cent. of nitroglycerine and 4 per cent. to 5 per cent. of nitro-cellulose, the balance being made up of wood pulp and a nitrate. The ordinary gelignite has about 60 per cent. of nitroglycerine and 3.5 per cent. of nitro-cellulose, and there are still lower grades. A 60 per cent. gelignite has about 75 per cent. to 80 per cent. of the strength of ordinary blasting gelatine. All these explosives have the gelatine characteristic; they are plastic and therefore accommodate themselves readily to the irregularities of a hole, and their plasticity is a feature tending to safety in charging a hole. But they have the defect, common to all nitro-glycerine explosives, of freezing or becoming hard in cold weather, so that in cold countries thawing houses form part of the equipment of every mine.

Within the past few years a remarkable discovery his been made as the result of experiments during many years, and, without going into details, it will suffice to say that a new form of nitro-glycerine will shortly be put on the market and will not freeze under severe weather conditions. The chemistry and physics surrounding this discovery are most fascinating, and it may be stated that fundamentally the new nitroglycerine is produced from polymerised glycerine, that is, glycerine of a higher molecular weight and of a slightly different chemical composition.

Most writers on the economics of mining state quite definitely that as a rule holes are overcharged, and that consequently explosive is wasted. This is doubtless in a measure true. But in all mining operations we are accustomed to lay stress on the 'safety factor,' and it is only reasonable that this should apply to explosives as well as to say, wire ropes. Mining engineers know only too well how costly it is to have a 'round' hung up through undercharging and yet, through parsimony or perhaps a real desire to economise, this happens more often than is generally recognised. Blasting is an art, not a science, therefore formulæ are of little use unless applied under well-defined and well-known conditions. How the results which we give agree with formulæ we have not attempted to find out. We have limited ourselves to setting out actual results, which show wide but not surprising variations. In everyday practice conditions vary considerably ;the burden, the fracture planes, the hardness, and the toughness, factors very difficult to define and determine, are constantly varying, and the wise shotfirer must err on the side of safety by using just a little more explosive than his judgment tells him is correct; and after all, the art of blasting is largely a matter of judgment based on experience. The skilled blaster will take advantage of every little point to make his holes 'come,' and it takes many years' apprenticeship for a man to acquire the necessary judgment. few can go from coal to rock without making grievous mistakes.

We wish, however, at this stage to draw special attention to the excellent results obtained by the 'Study Department' of the Central Mines Administration on the Rand from the systematising of the blasting in their mines. The description furnished by the Company is so concise and lucid that no further elaboration is required. These results are obtained from the application of judgment based on collective experience.

One point worth commenting on is the guestion of an explosive. Some of us talk very glibly, but often without much understanding about it, though we may know the theoretical potential mechanical units. We have highly artificial methods of testing what we call the strength, but these bear very little relation to practical conditions. The strength of an explosive is naturally the resultant of three entirely different things, first, the volume of gas produced, secondly, the rate at which the gases are evolved, and, thirdly, the heat generated. It is, however, a well-known fact that certain explosives which may indicate exactly the same strength when tested by the recognised methods, behave quite differently in practice. There are, of course, reasons for this, but we can only theorise regarding them. The choice of the best explosive for a particular class of work is not at all easy, and things are not made any simpler by the

nomenclature which is adopted for the so-called ' permitted ' class used in collieries.

Not long ago one of the authors had occasion to advise on the most suitable explosive for getting through an extremely hard and tough formation during shaft-sinking operations. He advised the use of one of the gelatines, and though it did the blasting all right, it shattered the rock so much as to delay the subsequent ' mucking.' A very much weaker and much-maligned explosive was tried and, contrary to all expectations, it did the work very well, just breaking the rock sufficiently to render the ' mucking ' easy. In 99 cases out of 100 this weak explosive would have been of no use at all, but it just suited the particular conditions.

Another case of a different kind came to our notice recently, where, through a wrong choice, the explosive consumption was double what it should have been. This, however, is somewhat exceptional.

One point regarding overcharging is worth exploring. It is quite conceivable that under certain conditions, and provided the roof is good, overcharging would pay. On the Rand, stamps will apparently be elimated from all new plants, and the comminution of the ore will be done by crushers and tube-mills. Provided the ore can be brought out clean and no sorting required, might it not pay to overcharge? This experiment might be worth a trial, and the suggestion will be made on the Rand. But if there is anything in the idea (and only experience will tell) some of our stoping statistics will be modified.

One hears a good deal, from time to time, of the wonderful shaft-sinking records, but we rather imagine that the consumption of explosives and stores generally, during the creation of these records must be comparatively high. Still, in laying out a big mine time is a very important factor, and it is not difficult to imagine that in many cases time is the greatest factor of all.

Reference has been made to the fact that the gelatine type of explosive is that commonly used within the British Empire, and our records show this clearly. We cannot say what proportion of the total consumption consists of explosives of a different category, but, as our figures include those of the Rand, it cannot be great. As a matter of interest, however, we append a few particulars of certain explosives, of which the names may not be familiar.

Klorex is a British high-density explosive consisting of about 90 per cent. chlorate of potash and the balance of oil.

Red Cross Extra 40 per cent. is an American dynamite, of a powdery consistence, and containing about 20 per cent. nitro-glycerine, the other principal ingredients being nitrate of ammonia and wood pulp.

Polar Ammonia Dynamite is similar in type to the preceding explosive, and Polar orcite is a gelatine. Both are of Canadian manufacture.

THE MELTING POINT OF PURE s-p-BROMOPHENYL-n-HEXYLTHIOCARBAMIDE.

By R. F. Hunter, M.Sc., Ph.D., D.I.C., A.R.C.S., and
C. Soyka, B.Sc., D.I.C., A.R.C.S.

In a recent paper on the mobility and unsaturation of the 5-bromo 1- alkylamino-benthiazole system (*J. Chem. Soc.*, 1926, CXXIX, 2958) we erroneously assigned the melting point of 189° to s-p-bromophenyl-n-hexylthiocarbamide. Actually the thiocarbamide obtained from the condensation of n-hexylamine with p-bromophenylthiocarbimide usually melts about 102-103°. On recrystallisation from 50 per cent. alcohol it forms soft lustrous plates m.p. 106°. (Found : Br, 25.2. Calc. Br, 25.4%).

Imperial College of Science and Technology,
London, S.W.7.

24 December, 1926.

NOTICES OF BOOKS.

Notes on the Exhibit of the Work of the Adhesives Research Committee.

The exhibit deals with the work of the Adhesives Research Committee of the Department of Scientific and Industrial Research, and is the result of a decision by the authorities of the Science Museum to make available facilities for temporary demonstrations of this kind of the progress and results of current scientific research. These notes have been prepared to give those interested in the exhibit some idea of the importance and scope of the problems dealt with by the Committee. Fuller information

of a more technical character will be found in the first and second reports of the Committee, published by H.M. Stationery Office in 1922 and 1926 (price 4s. and 3s. respectively). It should be added that arrangements have been made by the Department whereby British firms interested in the manufacture or use of adhesives and in the treatment of fish residues to produce gelatin and other products, may by payment of a subscription be kept closely in touch with the work at present in progress. Details can be obtained on application to the Secretary, Department of Scientific and Industrial Research, 16, Old Queen Street, Westminster, S.W.1.

Agricultural Research During 1925.

The issue of the above work reminds us of the useful and widespread work carried on by the Royal Agricultural Society of England. The cost of the work is 2s. 6d., and it is worth many times the money to all interested in agriculture. The contents include articles under the headings of crops and plant breeding, dairy husbandry, agricultural economics, agricultural engineering, animal nutrition, soils and manures, and veterinary science. The editor, Mr. C. S. Orwin, and the various contributors, are to be congratulated on the production of a valuable work.

A Manual of the Medical Aspects of Chemical Warfare.

The Great War brought the importance of chemistry prominently to the front, and if and when another big war takes place the science of chemistry is certain to play a prominent part and probably the most prominent part in the struggle. Bearing these facts in mind, the pamphlet issued under the above title by command of the War Council is opportune. It is well written, it gives a mass of useful and interesting information in a manner easily comprehended by an intelligent reader. Written obviously for the benefit of medical men whose services might at any time be required in the field, the information on the nature and injuries caused by poisoned gases and the precautions to be taken, the remedies to be applied, are given in clear and somewhat tabloid form, so that any medical man can keep in touch with such matters. Especially will this be the case when each new edition of the manual is to be brought up to date.

Turning to poisoned gases, we are told that they are of two main types, the persistent (mustard type), and the non-persistent. Gas clouds have a tendency to hang about hollows, dug-outs, etc. High winds, fog and rain largely nullify the effects of the gas. Some of the gases are slow and cumulative in their effects, ultimately ending fatally, while others are lethal in their effects, causing death in a minute or two and sometimes less.

Mustard gas (so-called from its smell), is an oily liquid resembling sherry in colour. Its boiling point is 217° C., and melting point 14.1° C. It vapourises slowly and so hangs about the ground for a long time. Its deadly effect will be understood from the fact that concentrations as low as 1 part of the vapour to 5 million parts of air will produce casualties after an exposure of about 6 hours upwards. The only chance of complete escape is removal within 10 to 15 minutes. Those affected after the lapse of a couple of hours, are troubled with irritation of the eyes and nose, which begin to water. Nausea and vomiting follow, conjunctivitis increase rapidly, then the throat becomes dry and burning, a dry cough developing, the neck and face becomes inflamed as if scorched and various parts of the body become affected, a troublesome itch follows and in 24 hours the condition of the patient is pitiful, as acute bronchitis and lung troubles develop, the death-rate being highest on the third and fourth days.

The acute lung irritant gases used in the War include phosgene, chlorine, chloromethyl chloroformate, trichloromethyl chloroformate, chloropicrin and phenylcarbylamine chloride.

The various gases are described, their effects on the victim traced and the approved remedies and treatment clearly described. There are given some illustrations, including those of three types of gas masks.

The price of this well written pamphlet of some 90 pp., is 9d., and it is published by H.M. Stationery Office, Adastral House, Kingsway, London, or any of its branches, and can, of course, be ordered through any newsagent.

Kolloidchemische Technologie. Edited by PROF. E. LIESEGANG. Vol. I., pp. 1-80, Vol. II., pp. 81-160. Dresden & Leipzig: T. Steinkopff. 1926. Price 5 marks per volume.

Volume I. of this series, chiefly contributed by Dr. Reitstötter, deals especially with the preparation of colloidal solutions of inorganic substances. The usual electrical and mechanical methods for obtaining bodies in the disperse system and the introduction of protective colloids are mentioned. There is then a detailed description of the preparation of colloidal solutions of the individual elements and their compounds, arranged after the Periodic Classification.

The literature, notably that concerning Patents, has seeemingly been well searched for the information concerning the occurrence and formation of individual substances in the colloidal state. Fortunately, it has been sifted and extensively condensed.

This is followed by an account of the industrial preparation of colloids in general. In the same volume Dr. F. Hebler describes some modern methods of ultrafiltration and dialysis. This is continued in Vol. II., where Dr. E. Mayer also presents an account of electro-osmosis, illustrated with photographs of machines specially concerned in the technical applications of colloids in industry.

Dr. H. Vogel's section on the viscosimetry of colloidal solutions is also begun in Vol. II.

The series is intended to constitute a comprehensive treatise on the science and technology of Colloids. The editor has secured the co-operation of many well-known authorities to write upon special branches of the subject, so that each issue will be anticipated with great expectations.

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

CANTOR LECTURES.

The first Cantor Lecture will be given on Monday evening, January 17, at 8 o'clock, by L. C. Martin, D.Sc., A.R.C.S., on "Recent Progress in Optics."

Lecture I.—Synopsis. Vast range of applications of optical instruments in industry, science, and ordinary life. The action of single optical surfaces explained by (a) ray tracks, (b) optical paths. Surfaces accurate to 0.00005 mm. Spherical v. aspherical surfaces. The advance of grinding and polishing methods. Large astronomical reflectors and their testing. What is an optical image? The inadequacy of geometric theory. Measuring the diameter of a star.

Wednesday, January 19, at 8 o'clock.—Sir John Cadman, K.C.M.G., D.Sc.: "Development of the Petroleum Industry in Persia" (illustrated).

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

31,612.—Binz, A.—Production of 2-oxy-3-bromo-5-pyridinearsinic acid. December 13th.

32,106.—Chemical Works formerly Sandoz. Production of dyestuffs. December 18th.

32,037-32,038.—Harris, J. E. C.—Dyes, etc. December 17th.

31,938.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of trisazo. December 16th.

Specifications Published.

262,494.—Dreyfus, H. — Manufacture of methyl-alcohol.

262,537.—Akt.-Ges. fur Anilin-Fabrikation. Process for producing fast dyeings on the fibre.

262,546.—Mackay, A. S.—Electrochemical processes and apparatus for the extraction of copper and zinc from ores.

262,703.—Hanovia Chemical and Manufacturing Co.—Method of enhancing the therapeutic value of ultra violet rays.

Abstract Published.

260,588.—Dyes.—I. G. Farbenindustrie Akt.-Ges, Frankfort on Main, Germany.

Anthraquinoneacridone dyes are prepared by heating a 1-chloranthraquinone-2-carboxylic acid with an arylamine in an inert organic solvent until the formation of dyestuff is complete. A condensing agent may be present, particularly one of weak acid character such as borax, boric acid, potassium bisulphate, arsenious acid. antimonious acid, phthalic acid, or benzoic acid. According to examples 1-chloranthraquinone-2-carboxylic acid is condensed with β-naphthylamine in presence of nitrobenzene, or oxalic acid and naphthalene, or sodium acetate or boran and trichlorbenzene; 1-chloranthraquinone-2-carboxylic acid is condensed with *p*-chloraniline in presence of boric acid and trichlorbenzene. Specification 894/11 is referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

NAPHTOLAS.

462,790.—Artificially or synthetically prepared coal tar dyestuffs in Class 1, and chemical products in Class 1, for dye and lake production and for use in dyeing and printing textile fabrics.—Chemische Fabrik Griesheim-Elek-Tron, 31, Gutleutstrasse, Frankfurt-on-the-Main, Germany. December 22nd.

PLASMOQUINE.

474,634.—Chemical substances prepared for use in medicine and pharmacy.—Bayer Products, Limited, 31 to 34, Basinghall Street, London, E.C.2. December 22nd.

FOR SALE.

Baker Steel Roll Refiners.—Particulars to Box No. C. B. B., c/o *Chemical News* Offices, Merton House Salisbury Square, London, E.C.4.

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NITRATION OF CELLULOSE IN THE PRESENCE OF PHOSPHORIC ACID.

By C. K. KRAUZ AND F. J. BLECHTA.

(Institute of Explosives, Technical University of Prague, Czechoslovakia.)

(Continued from Last Week.)

II.

INFLUENCE OF PROPORTIONS OF DIFFERENT ACIDS IN NITRATING MIXTURES.

Desiring to establish the best proportion of phosphoric acid to nitric acid we used both these acids as concentrated as possible, because, as is seen in Table II., diluted nitrating mixtures gave poor results. The nitric acid had 99.50 per cent. HNO_3 and the phosphoric acid contained 100 per cent. H_3PO_4. Each was cooled before mixing to 20° C. The proportion of cellulose to nitrating mixture, the time and temperature of nitration were maintained as in preceding experiments.

TABLE III.

Expt.	HNO_3 : H_3PO_4	Gr. Subs.	NO c.c.	°C.	P.	N per cent.
10	1 : 1	.2608	58.6	19	749	12.93
11	1 : 2	.2593	56.2	14	744	12.64
12	1 : 3	.2684	56.4	15	744	12.20
13	1 : 4	.2642	56.7	21	739	11.92
14	1 : 6	.2550	52.7	18	732	11.73
15	1 : 8	.2526	50.08	16.5	725	11.36

TABLE IV.

Expt.	HNO_3	H_3PO_4	H_2SO_4	Gr. subs.	NO c.c.	°C.	P.	% N
16	25.0	22.5	2.5	.2589	59.5	20	734	12.95
17	25.0	20.0	5.0	.2626	60.8	21	729	12.92
18	25.0	17.5	7.5	.2607	59.9	19	730	12.93
19	25.0	12.5	12.5	.2628	61.0	19	726	12.95

This series also shows differences in actions of nitrating mixtures with sulphuric acid and those with phosphoric acid. With sulphuric acid, products of 13,6 per cent. N can easily be prepared with nitro-phosphoric acids, however, the highest N-content is 13 per cent. Another interesting difference observed is the fact that, when sulphuric acid has been used, the percentage of nitrogen in the products increases with increasing quantity of this acid till the ratio is 1 : 3, but phosphoric acid causes a successive and constant fall of N percentage with ascending concentration.

These phenomena can be explained only if we suppose that phosphoric acid is a mere diluting agent and the nitrogen in nitrocelluloses thus prepared must always be proportional to the relative amount of pure nitric acid contained in the given nitric-phosphoric acid. The correctness of this view seems to be proved by the fact that in none of the experiments (10 to 15)—where practical anhydrous mixtures throughout has been used—no solution of nitrocelluloses was observed, whereas this does occur initially when nitric acid acts alone.

The action of anhydrous nitric-phosphoric acid suggests an immediate generation of cellulose nitrates insoluble in phosphoric or nitric acid. Different conditions take place in presence of water in the same nitrating mixture in which decomposition of cellulose by nitric acid occurs more rapidly than the nitration (esterification) process alone.

To prove the correctness of this we tried to perform the nitrations in the presence of sulphuric acid, using nitric acid, 99.5 per cent. HNO_3, 100 per cent. H_3PO_4, and 95 per cent. H_2SO_4, mixing them so that in this mixture, as was used in Experiment 1, Table II., some phosphorie acid was replaced by the same amount of sulphuric acid. Thus the proportion of cellulose to nitrating mixture, time of operating, and temperature, were all maintained the same as above. The nitration went normally, and no dissolving of products was observed.

As may be seen from Table IV., the influence of phosphoric acid seems entirely paralysed by sulphuric acid, for in all cases, nitrocelluloses with the same percentage of nitrogen resulted.

Besides N determinations we examined the nitrocelluloses for their content of sulphuric and phosphoric acids. For this purpose we made a larger quantity of nitrocellulose by treating dry cotton with the same nitrating mixture used in Experiment 17, washing the product in cold water till neutral, boiling it for 1 hour in .1 per cent. soda, washing in cold water again, squeezing out and drying; found, 12.88 per cent N. About 5 grams of this sample were then decomposed by boiling in conc. nitric acid, the solution obtained was evaporated on the water-bath, diluted and divided into two parts. The first part, acidified with hydrochloric acid, yielded with barium chloride solution a sediment of barium sulphate, while the second one, treated with ammonium molybdate solution gave after 24 hours' standing no trace yellow precipitation of phospho-molybdate. *These results prove plainly that even in the presence of sulphuric acid phosphoric acid has no action on nitrocellulose for sulphuric esters of nitrocellulose are produced as in the absence of phosphoric acid.*

III.

Influence of Time on the Nitrating Process.

For these experiments we used anhydrous mixtures of nitric and phosphoric acids in the proportion 1 : 1, *i.e.*, as in Experiments 1 to 10. While the proportion of cellulose to acids mixture (1 : 50) and the temperature (20° C.) were also the same, only the time of operations was changed. The products of these nitrations, however, were merely washed in cold water to avoid any elimination of nitrogen by boiling and to be able to better compare the results of analysis, which are given in Table V. :—

Table V.

Expt	Time hrs.	Gr. subs.	NO c.c.	°C.	P.	%N
20	1	.2585	54.8	13	736	13.06
21	2	.2581	59.6	18	736	13.13
22	4	.2600	60.2	15	732	13.26
23	8	.2568	60.5	19	730	13.25
24	16	.2594	60.8	20	732	13.16
25	48	.2606	60.2	18	730	13.01

In accordance with results generally obtained in nitrating cellulose in presence of sulphuric acid the percentage nitrogen in nitrocelluloses increases with increasing time of action, and, reaching a maximum it decreases again owing to a saponifying influence of the nitrating mixture on nitric esters. A remarkable difference, however, appears in the reaction velocity; while with nitric-sulphuric acid we easily obtain nitrocelluloses with 13.2-13.3 per cent. N in 30 to 60 minutes and even with 10 per cent. water in the mixture, perfectly anhydrous nitric-phosphoric acid needs at least 4 hours.

The experiments just described prove that the nitration of cellulose in the presence of phosphoric acid goes much more slowly than that with nitric-sulphuric acid.

IV.

Influence of Temperature on the Nitration.

In examining the influence of time we nitrated the cellulose with nitric-phosphoric mixture of the same composition as in Experiments 1, 10, and 20 to 25, where the other conditions, except temperature, were maintained the same. With the exception of an elevated solubility of products the temperature being above 30°C., no abnormalities were observed :—

Table VI.

Expt.	°C.	Gr. subs.	NO c.c.	°C.	P.	% N.
26	20	.2585	54.8	13	736	13.06
27	30	.2622	60.9	20	732	13.05
28	40	.2565	58.8	19	732	12.95
29	50	.2600	59.5	19	732	12.90
30	60	.2600	59.0	18	732	12.83

These results indicate that elevated temperature disadvantageously affects not only the solubility of nitrocellulose, but also its nitrogen percentage which, as a consequence of denitrating action, decreases.

V.

Influence of Phosphoric Acid in Nitrating Mixture on the Chemical Stability of Nitrocellulose.

For these stability examinations we used nitrocellulose samples from experiments 20 and 22, Table V, which were washed perfectly in cold water, boiled about 15 minutes in 0.1 per cent. soda, again washed and dried. We applied the Horn test at 130° C., and determined the *explosion point*. Nitrocellulose prepared in the same way but with sulphuric acid, was compared with it.

In the Horn test the samples prepared with sulphuric acid regularly exploded after a few minutes already while the samples 20 and 22 indicated no decomposition even after 75 minutes heating as the colouration of the gases in the tube became only faintly yellow.

The *explosion point* of a good nitrocellulose has generally not to be lower than 182° C., whereas our samples decomposed at the limits of 179° to 181° C. Being, however, in all cases made, products with remarkably high percentage of nitrogen, *i.e.*, over 13 per cent. N, and being besides in no pulped and no stabilised state (a short boiling cannot be taken for stabilisation) the results of these tests may also be considered as entirely satisfactory.

By nitrating cellulose with nitric- phosphoric acid, quite stable nitrocelluloses are obtained after simple washing in pure water only, pulping and stabilising can be omitted without danger.

This proves again the supposition I mentioned, *viz.*, that phosphoric acid does not affect the nitration of cellulose.

Summary.

In studying whether sulphuric acid can be replaced by phosphoric acid in the nitrating mixture some circumstances were found of theoretical and practical interest.

Thus, phosphoric acid mixed with nitric acid acts on cellulose in a different manner to sulphuric acid.

The action of an anhydrous mixture of equal parts of both on cellulose leads to nitrates with about 13 per cent. N. In the presence of small amounts of water, the nitration is incomplete and accompanied by an intense or complete dissolving of products in the mixture. While nitric-sulphuric acid containing 18 per cent. water yields a nitrocellulose with 12 per cent. nitrogen, dilute nitric-phosphoric mixture gives a product with hardly 5 per cent. N. It seems, therefore, that phosphoric acid is a diluting agent only. These nitrocelluloses contained no phosphoric acid. No phosphoric esters of nitrocelluloses are formed.

While in the presence of sulphuric acid in the nitrating mixture ,nitrocellulose with 13.6 per cent. N can easily be obtained, nitric-phosphoric acid gives a maximal content of only 13 per cent. N. The optimal proportion of nitric to sulphuric acid usually is 1 : 3, but only 1 : 1 for H_3PO_4-HNO_3, where the presence of phosphoric acid causes a successive and constant drop of the nitrogen percentage with ascending concentration, proving again that this acid does not react in a specific manner but only as a diluent. The best proof of this is the fact that a small addition of concentrated sulphuric acid reverses this influence, and sulphuric esters of nitrocellulose are produced quite as much as in absence of phosphoric acid.

The nitration of cellulose in presence of phosphoric acid goes much more slowly than in the case of nitric-sulphuric acid. In accordance with results generally obtained in the presence of sulphuric acid, the percentage of nitrogen in the products increases with increasing time of action, and having

reached a certain maximum the percentage again decreases. In using nitric-sulphuric acid, even diluted with 10 per cent. water, nitrocelluloses with 13.2 to 13.3 per cent. N can be easily obtained in 30 to 60 minutes, while with perfectly anhydrous nitric-phosphoric acid, 4 hours is needed.

The influence of elevated temperature during nitration in the presence of phosphoric acid shows no abnormalities. Till 30° C. the reaction passes normally, at higher temperature, however, the drop in nitrogen percentage in the products and much solubility in the mixture takes place.

The chemical stability of nitrocelluloses prepared by the action of nitric-phosphoric acid on cellulose can be considered very good for phosphoric acid does not act on cellulose and simple washing of the nitrated products in pure water till neutral is sufficient to give a stable nitrocellulose.

The use of phosphoric acid in nitrating mixtures instead of sulphuric acid would represent a considerable advantage as simple washing after nitrating gives perfectly stable products. The lengthy and expensive stabilising process—steaming, pulping and boiling, can be omitted. In practice it would be necessary to work with almost anhydrous mixtures for, otherwise, the yields of nitrocellulose would be too low. The time of nitrating would also be longer and loss of acids during regenerating would be much greater than with nitric-sulphuric acid. The most important factor is the price of phosphoric acid.

Under present conditions nitric-phosphoric acid mixtures could conveniently be applied in laboratory work only.

POSSIBLE CAUSE OF THE CHANGES OF COLOUR IN VAPOURS.

By Florence Langworthy.

The vapour of mercuric chloride, when illuminated by the spark, is green, but the vapour of mercuric bromide is blue and that of mercuric iodide is violet. As there is one atom of mercury in each of these molecules the two halogen atoms are evidently responsible for this change of colour. How are we to account for it?

I venture to think that the answer is to be found in the fact that the atom grows more positive, as a whole, as it increases in weight. For though it grows more negative as it progresses from lithium to oxygen, yet if we consider the elements ranged under oxygen in the Periodic Table we shall find that chromium, for instance, is more positive than sulphur, while selenium is more positive than chromium. Thus the atom can, apparently, at certain stages hold up an extra positive. The atomic weight seems to indicate these stages. The unit by which the atom increases in weight appears to be two, save for the monatomic gases where four is added. After helium 4 comes lithium, which has two isotopes, 6 and 7. In lithium^{6} we will suppose that we have the undamaged atom. If the atom is damaged then the isotopes may be either higher in weight—should the atom be repaired—or lower, if for any reason it is not repaired. The next element, beryllium, gives us the damaged atom only, beryllium^{9}. But with boron we get both boron^{10} and boron^{11}. Carbon yields only the undamaged carbon^{12}, nitrogen, the undamaged nitrogen^{14} and oxygen the undamaged oxygen^{16}. With fluorine we get only the damaged fluorine^{19}, but if we add to the undamaged fluorine^{18} the four needed for the monatomic gas, neon we have the two isotopes of the latter, 20 and 22. This reckoning by twos and fours will bring us to the exact weight of titanium, 48, an element that has no isotopes. The first extra positive appears to come into the atom with selenium. There is a rise in weight from arsenic 74.98 to selenium 79.2. If we look upon arsenic^{74} as undamaged arsenic then we shall have selenium^{76} and selenium^{78} for the undamaged twin-element. The damaged element will have isotopes both higher and lower than these. The next twin-element seems to be cadmium. There is a rise from silver 107.88 to cadmium 112.4. The weight of silver points to 108 and this would give up a cadmium^{110} and a cadmium^{112} for the undamaged twin-element. Cadmium^{112} is followed by indium 114 and then there is another rise to tin 118.7. So we apparently have another twin-element, a tin^{116} and a tin^{118}. One of the isotopes of tin is a tin^{116}. After tin comes the damaged antimony 121.77 and then there is another jump to tellurium 127.5. The undamaged antimony would be 120 so the undamaged tellurium twin-element should contain a tellurium^{122} and a tellurium^{124}. The element, iodine, which follows, has the weight 126.92 indicating that the undamaged iodine has the expected weight of 126 so the excess in weight of tellurium is evidently due to something abnormal. With selenium and tellurium as twin-

elements we shall expect to find holmium the same, but there is not this rise in weight from dysprosium to holmium. The rise comes between the damaged holmium 163.5 and erbium 167.7. This would seem to indicate that in holmium one of the twins has disappeared and that there is a holmium[161] (undamaged) still to be found. The remaining twin-elements appear to be mercury, lead, polonium, radium, thorium, and uranium.

The following quotation is from Baly's "Spectroscopy" (p. 464):—

"An interesting comparison may be drawn between the three halogens—the absorption lines shift nearer the red with increasing atomic weight; similarly also do they increase in number and sharpness; and, further, the thickness of gas layer required to render the absorption lines visible decreases with increase of atomic weight."

With the bromine atom containing one more extra positive (in selenium), than the chlorine atom and with the iodine atom containing three more extra positives (in cadmium, tin, and tellurium), than the bromine atom, we can understand this shift towards the red.

Red is undoubtedly the positive colour. The great red prominences of hydrogen A thrown off by the sun; the intensely red light of lithium, of strontium, of rubidium, go to prove this. But since even oxygen can show its red lines we should have to admit that oxygen has its positive atoms even if we did not know that oxygen positives make their appearance among the Positive rays. So, too, with lithium that not only has red lines but green, showing us that the positive elements have their negative atoms even as the negative elements have their positive atoms. But negative oxygen will naturally be much more negative than negative lithium. When, therefore, we consider mercuric chloride we can picture the two negative chlorine atoms as obscuring any light thrown off by the mercury atom to which they are attached and so giving us a negative green light. When, however, we come to mercuric bromide the light has changed to blue. To turn green into blue, violet must be added. From where is this violet to come? We have the short violet rays, but how do they come in here? If we bear in mind that bromine is more positive than chlorine we may find the answer. For the violet rays are at the negative end of the spectrum and so the more positive an element is the more likely they are to be attracted to its vicinity. This is apparently borne out by the fact that when we come to the mercuric iodide the colour has changed from blue to violet. If we picture the atomic sun in each of these halogen atoms as attracting to itself the little negative particles and throwing them off as rays then we shall not be surprised to find that the iodine atoms, as the most positive, are the most successful of the atoms of the three halogens in attracting these negatives.

General Notes.

NEW YEAR PROSPECTS FOR CHEMICALS.

In a New Year message to the British Industries Fair number of the "Advertising World," Mr. W. J. U. Woolcock, General Manager, the Association of British Chemical Manufacturers, writes:—"The prospects for the British chemical industry in 1927 are distinctly good. Probably no other industry has suffered less as a result of the coal dispute. Therefore recovery in the new year is likely to be at least as rapid as, and probably more rapid than in any other industry. The chemical exhibits in the British Industries Fair will show how every firm is extending its range of goods and that very considerable progress has been made in the last year, particularly in regard to fine chemicals. So far, chemical products, apart from those like soap, have not been widely advertised because their appeal is not to the general public but to the trade buyer. The Fair brings the manufacturer into direct touch with him. It is of immense propaganda value, also in emphasising the importance of the application of science to industry. If we are to maintain our industries against world competition, science, which finds its greatest application in this industry, must permeate every industry to a like extent.

"Despite the fact that the recent great chemical "merger" did not take place until after all space had been booked in the chemical section of the fair, Imperial Chemical Industries, Limited, is to exhibit, arrangements having been made to take over the centre space reserved for one of the constituent companies. This, of course, will be the new company's first exhibit and will include heavy chemicals, dyestuffs and intermediates.

BRITISH COLUMBIA MINERAL PRODUCTION BREAKS ALL RECORDS.

Both the quantity and value of the mineral production of British Columbia will establish new high records in 1926, according to the Hon. Wm. Sloan, Provincial Minister of Mines, who has issued a summary of the mining activity in the present year.

The figures compiled by Mr. John D. Galloway, Provincial Mineralogist, show that the aggregate value of the 1926 production will be approximately $67,718,400 compared with $61,492,242 in 1925, an increase of approximately 11 per cent. over the previous record production in 1925, and this in face of lowered average metal prices. There has been a consistent growth in the mining industry in British Columbia in the past five years. In 1921, the value of the output was $28,066,641.

"British Columbia's contribution to world wealth has been a most notable one," said Mr. Sloan, who pointed to the fact that since mining commenced in the Province in 1852, the total value of mineral production has been approximately one billion dollars, or, to be exact, $989,000,000. The recent tremendous growth is indicated by the fact that over 50 per cent. of this total has been produced in the last twelve years.

The greatest increase expected this year is in the value of copper production, estimated at 91,000,000 pounds, valued at $13,650,000, compared with 72,306,432 pounds last year valued at $10,153,269. Zinc production is estimated at 135,000,000 pounds, valued at $10,000,000 compared with 98,257,099 in 1925, valued at $7,754,450.

CANADIAN WATERSHED HELPING TO FEED THREE OCEANS.

The survey of the boundary between the provinces of Alberta and British Columbia established the existence of a watershed from which water flows to three different oceans. The Columbia ice-field which covers an area of about 110 square miles, culminating in the Snow Dome, gives rise to glaciers which feed mountain streams tributary to the Columbia, Athabaska, and Saskatchewan rivers, emptying eventually into the Pacific, Arctic, and Atlantic oceans respectively.

CONSUMPTION OF ELECTRICITY.

Canada now leads the world in the public per capita distribution of electricity from central electric power stations. The figures of kilowatt-hours generated per capita per annum by the five leading countries are: Canada 1,260; Switzerland, 886; United States, 581; Sweden, 467; Norway, 370.

CANADA'S EXPLOSIVES PRODUCTION.

Production of explosives, ammunition, fireworks and matches in Canada in 1925 amounted in value to $12,313,155, according to the Dominion Bureau of Statistics. Explosives produced during the year were valued at $,999,856, ammunition at $2,129,975; fireworks totalled $128,684 in value and the output of matches $2,054,640.

SOUTH AFRICAN TRADE BALANCE.

Owing to the reduction in the total value of exports of farm produce, especially maize, it is estimated that the favourable balance of Union of South African trade, which amounted to 19 million pounds for 1925, will be reduced to about 11 million pounds for this year.

CLEARING OFFICE REPORT.

ADMINISTRATION OF EX-ENEMY PROPERTY.

Following is a short survey of the Sixth Annual Report of the Controller and Administrator of the Clearing Office (Enemy Debts) and the various other administrations liquidating property, rights, and interests on behalf of British creditors and claimants in cases arising out of the Great War.

GERMAN ADMINISTRATION.

The Clearing Office has paid to date to British creditors and claimants under Articles 296 and 297 of the Treaty of Versailles in respect of pre-war debts, proceeds of liquidation of British property in Germany and compensation a total sum of £83,475,263 18s.

OUTPUT OF SILICA IN CANADA INCREASED.

During 1925 the production of quartz (silica) in Canada was considerably higher than the total recorded in the preceding year. According to statistics issued by the Dominion Bureau of Statistics shipments of quartz during 1925 reached a grand total of 197,224 tons valuedat $363,612 as compared with 150,896 tons at $323,156 shipped in 1924.

INCREASE OF BRITISH MOTOR VESSELS.

There were on the registers at United Kingdom ports at the end of last year 1,965 motor vessels, totalling 498,731 net tons, or 7.79 per cent. more in number and 29.59 more in tonnage than at the close of 1924. Last year's additions included 105 new motor ships of 118,000 net tons.

UNDERGROUND RAILWAYS OF LONDON.

In a recent paper read before the Institution of Electrical Engineers, Mr. Arthur R. Cooper dealt with the electrical equipment of track on the underground railways of London.

The paper gives a few historical facts leading to the adoption by the District Railway of 600 volts direct current with the insulated return, and makes reference to the starting up of the Tube lines. It also deals with :—

Some results in working the insulated-return system.

Conductor rails; material used, section, conductivity, loss of weight, anchoring, and data with regard to the painting of rails.

Types of insulators used, and data with regard to cleaning and insulation.

Injurious effect of electric burns on track rails.

High-tension cables.

Maintenance of track equipment, including methods adopted for clearing conductor rails of ice or snow.

Operating arrangements for removing and restoring current.

Some particulars are also given of certain special instruments used by the Underground Railways. The conclusions reached by these Railways are set out at the end of the paper.

A THREATENED INDUSTRY.

Under this title the *Electrical Review* has called attention to an aspect of the Government electricity scheme of which little notice has so far been taken. It points out that the scheme must affect detrimentally the engine-building industry, so far as the home market is concerned, inasmuch as it will destroy the demand for the smaller generating sets, and steam and oil engines of the lower powers. There is another point. It is that the reduction of the electricity stations in the country, and the amassing of production in large unit stations, will tend to bring about the concentration of the manufacture of the plant in the hands of two or three firms, which will wipe out the free competition which exists at the present time.—*Gas Journal.*

SAFEGUARDING OF KEY INDUSTRIES.

The Board of Trade state—

"Additional lists of articles chargeable with duty under Part 1 of the Safeguarding of Industries Act, 1921, have been issued by the Board of Trade, and will take effect as from 15th January, 1927. These lists refer to articles under the following headings :—Optical Glass and Optical Elements; Optical Instruments; Laboratory Porcelain; Scientific Instruments; Synthetic Organic Chemicals. Copies of the Lists may be obtained from His Majesty's Stationery Office, price 2d. net."

IMPERIAL CHEMICAL INDUSTRIES LIMITED.

A skeleton map of England and Scotland has been issued which indicates the above company's operations in Great Britain. In Scotland the Nobel Industries, Ltd., have their main group of factories, chief among which is the parent factory at Ardeer. Moving south we come to an important factory of Messrs. Brunner, Mond and Co., Ltd., at Billingham, which is the headquarters of Synthetic Ammonia and Nitrates Ltd. This is on Tees-side, while on Tyne-side at Gateshead the United Alkali Co., have large works.

Next we find a large group of factories, offices, agencies, mines, etc., of the four companies comparatively close together in Yorkshire, Lancashire and Cheshire, the large group of explosives factories centred round Birmingham, and from the western districts bordering on the British Channel large quantities of primary chemicals are obtained. Other factories, offices, wharfs, etc., are grouped together in London and surrounding counties, chief among these being large soda crystal works at Silvertown. And finally in two factories in Cornwall, essential accessories for the explosives industry are produced.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made

during December, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 552, of which 446 were from merchants or importers. To these should be added 11 cases outstanding on the 30th November, making a total for the month of 563. There were dealt with as follows:—

Granted—444 (of which 427 were dealt with within 7 days of receipt).

Referred to British Makers of similar products—54 (of which 46 were dealt with within 7 days of receipt).

Referred ot Reparation Supplies available—3 (all of which were dealt with within 2 days of receipt).

Outstanding on 31st December, 1926—62.

Of the total of 563 applications received, 478, or 85 per cent., were dealt with within 7 days of receipt.

A BAD EXAMPLE.

The Chemical Warfare Research Department advertised for an engineer with works experience, who had a University education, and several other qualifications, and offered the absurdly inadequate salary of £265. We congratulate the Institute of Chemistry in its action in protesting against and remonstrating with this department on its rather mean action. £500 per year would be quite small enough for a man with the qualifications mentioned. We hope no qualified man replied to the advertisement, which had a tendency to degrade an important profession.

SECTION OF THE INSTITUTE OF CHEMISTRY IN NEW ZEALAND.

A local Section has, we learn, been formed in New Zealand.

SIR ERNEST RUTHERFORD HONOURED IN THE U.S.A.

Sir Ernest Rutherford, Director of the Cavendish Laboratory at Cambridge, has been awarded a prize of 1,000 dollars by the Sigma XI. National Scientific Honour Fraternity, meeting at Philadelphia in connection with the Convention of the National Association for the Advancement of Science. The prize was awarded for his work as Director of the laboratory.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read on Thursday, January 13, 1927, at 4.30 p.m.—

Changes in the Ovary of the Mouse, following Exposure to X-rays. Part I.—Irradiation at 3 weeks Old. By F. W. R. Brambell, A. S. Parkes, and Una Fielding. Communicated by Prof. J. P. Hill, F.R.S.

1. Ovaries of 47 female mice, exposed to full sterility dose of X-rays at 3 weeks old are described.
2. Irradiation is followed by degeneration of all oocytes.
3. Membrana granulosa and theca interna, in those cases where differentiated, degenerate also. Finally old follicles are only represented by small cavities containing zona pellucida remnants.
4. In few cases larger follicles become filled with blood and form cysts, or cells of theca interna and membrana granulosa grow and, invading antrum, form a corpus luteum antreticum.
5. These corpora lutea antretica persist indefinitely, but have no influence on œstrous cycle.
6. Simultaneously with these changes old inter-follicular tissue atrophies, and germinal epithelium proliferates epithelial cords.
7. In adult animals ovaries are composed almost entirely of this first proliferation. It tends to become like luteal tissue in some cases. Apparently it is responsible for production of œstrin, except in these latter cases.
8. In many cases a second proliferation from germinal epithelium follows. This consists of small, spherical or slightly elongated cords. These cords resemble so-called spermatic cords described in ovaries of inbred rabbits and of free-martin cattle. They also resemble structures described as anovular follicles.
9. Cords of second proliferation appear to have no effect on œstrous cycle.

Changes in the Ovary of the Mouse, following Exposure to X-rays. Part II.—Irradiation at or Before Birth. By F. W. R. Brambell, A. S. Parkes and Una Fielding. Communicated by Prof J. P. Hill, F.R.S.

1. Ovaries of 6 mice X-rayed *in utero* and of 30 X-rayed at birth are described.

Results confirm those obtained with mice X-rayed at 3 weeks old.

2. Degeneration of oocytes and follicles is followed by two successive proliferations from germinal epithelium in form of cords.

3. Some degenerating follicles produce cysts, or corpora lutea atretica, which latter may persist indefinitely, but have no effect on œstrous cycle.

4. Of animals irradiated at birth 24 were allowed to become adult. Cords of first proliferation constituted bulk of all ovaries; those of second proliferation were only found in 11 cases. Follicles were completely absent in all but one case.

5. These 24 animals divide into three groups. (1) The cells of first proliferation small, shrunken and vacuolated. Œstrous cycles irregular, in some cases prolonged vaginal cornification. (2) Cells of first proliferation large, healthy and glandular, somewhat resembling luteal tissue. Œstrous cycles normal and regular. (3) Cells of first proliferation very closely resemble luteal tissue. Œstrous cycle absent or ceased for at least 36 days previous to being killed.

6. It is concluded that cells of first proliferation are responsible for production of œstrin and regulation of œstrous cycle. Production of œstrin stops at certain stage of differentiation into luteal-like cells.

On the Occurrence of the Œstrous Cycle after X-ray Sterilisation. Part II. Irradiation at and Before Birth. By A. S. Parkes. Communicated by Prof. J. P. Hill, F.R.S.

(1) Further evidence is brought forward in support of conclusion previously arrived at, *i.e.*, that all normal cyclic œstrous phenomena except ovulation can occur in animals in which Graafian follicles of ovary have been totally destroyed at early age by exposure to X-rays, and can occur, therefore, in absence of organised corpora lutea and Graafian follicles.

(2) The main series of animals described were irradiated immediately after birth. A smaller series, of which only one sterilised animal survived, were irradiated *in utero* before birth. In the two series, 63 periods of œstrus were observed in 24 sterilised females.

(3) Nine animals, however, showed only six periods in all, and were found to have ovaries composed almost entirely of luteal-like tissue. Since absence of œstrous cycle cannot be directly ascribed to absence of follicles, it is supposed that its absence was due to direct mechanical inactivation of normal sterilised ovary by destructive development of luteal tissue.

(4) Observation of 57 periods of œstrus in the other 15 sterilised females, whose ovaries possessed neither Graafian follicles nor corpora lutea vera, is direct supplementary evidence that neither of these structures is essential for regulation of cyclic phenomena which constitute œstrous cycle of accessory reproductive organs, and, in conjuntion with previous results, seems to prove this point.

(5) Light thrown by the experiments on regulation of normal œstrous cycle is discussed.

Recovery from Vigorous Exercise of Short Duration. By R. M. Sargent. Communicated by Prof. A. V. Hill, F.R.S.

(1) Recovery from vigorous exercise of short duration is extremely rapid, especially in first 10 minutes immediately after cessation of exercise. Average recovery curves are given.

(2) Rate of recovery varies somewhat with subject and severity and duration of exercise. It is impossible to arrive at any average figure adequately representing percentage-recovery at any time after end of exercise, for different subjects and exercise of differing severity.

(3) It is inadvisable, in determining total recovery-oxygen after exercise, to measure amount used during period of incomplete recovery and apply a correction.

(4) As result of exercise oxygen consumption at rest was found to be increased, on average about 7 per cent. This change appears to result from genuine alteration in level of metabolism, and cannot be regarded as an integral part of recovery process as such.

THE INSTITUTION OF MINING ENGINEERS.

Abstract from the Thirty-Seventh Annual Report of the Council, Year 1925-26.

The Council, as members are aware, submitted evidence before the Royal Commission on the Coal Industry (1925), and Dr. J. S. Haldane, President, Mr. E. O. Forster-Brown, Member of the Council, and Mr. Edmund L. Hann, Member of the Council, appeared before the Commission as witnesses on behalf of the Institution, and their

examination and cross-examination occupied about one and a half days. In addition to their attendance at numerous meetings of the Council and of Special Committees, when the preparation of the evidence was under discussion, these gentlemen devoted a great deal of time and thought in their endeavour to give effect to the Council's earnest desire that the evidence of the Institution should be as complete and as helpful to the Commission as the complexity of the problems and the time available would permit. The thanks of their colleagues have already been conveyed to them, and the Council desire to place on record an expression of the indebtedness and appreciation of the Institution for their special personal services in this connection, and for the particularly valuable assistance rendered by the Secretary, Mr. C. McDermid.

In summing up their "Memorandum of Evidence," the Council of the Institution stated that in their considered view it was "owing mainly to certain recently-imposed inelastic and onerous conditions, in particular a uniform reduction of actual working-time per shift, that the working costs of coal-mining in Great Britain have been so raised as to place the industry in its present position of being unable to maintain its output and financial stability while at the same time paying satisfactory and regular wages to those employed"; and that they could see no solution of the trouble except through modification of these conditions. The correctness of these views has been confirmed by subsequent events.

In summing up their replies to the six questions on "colliery hours with attendance," the Councils of the Institution and of the South Wales Institute of Engineers stated that they had no hesitation in expressing the opinion that the increase of the allowable length of shift from 7 hours to 8 would be of much the greatest value of any of the alternatives embodied in the series of questions in reducing working costs and combating the tendency to reduced output, closing down of pits, and widespread unemployment. The only other alternative in the series that was capable of general application and offered beneficial results was that which referred to greater elasticity of hours for dealing with local difficulties underground.

Atmospheric Conditions in Hot and Deep Mines.

The work of the Institution Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines" has continued uninterruptedly in connection with the Birmingham University Mining Research Laboratory and the Safety in Mines Research Board. The Tenth and Eleventh Reports to the Committee have been issued to the members of the Institution during the year, and are printed in Volumes LXX. and LXXI. of the *Transactions*.

Gob-Fires Committee.

Following the issue of a Memorandum on "The Shutting-off of Gob-fires in Gassy Seams," the Committee have had under consideration the question of the probable effects of reversing the air-current in a mine in the event of a fire of an explosion. The Committee have arrived at the conclusion that before any reliable recommendations can be made it is necessary that experiments on the reversal of the air-current must be conducted and samples of air taken for analysis. A member of the Committee has undertaken to carry out the necessary experiments at a colliery under his charge, and to collect the necessary data for the guidance of the Committee in their further consideration of the question.

The Committee also have under consideration the question of the provision of explosion-proof stoppings.

"Mavor and Coulson" Travelling Post-Graduate Scholarship.

The Council have accepted a generous offer made by Messrs. Mavor and Coulson, Ltd., of Glasgow, of a sum of £300 for a further year, for a Post-graduate Travelling Scholarship. The itinerary of the selected candidate must include visits to Canada and/or the United States of America.

The Scholarship for 1926-1927 has been awarded to Mr. William Edward Skyrme Peach, holder of the Joint Diploma in Coal-mining of the University College of South Wales and Monmouthshire and the South Wales and Monmouthshire School of Mines.

Institution Medal.

By the unanimous vote of the Council, the Institution Medal has been awarded to Sir John Cadman, K.C.M.G., D.Sc., in recognition of his distinguished services to the Institution, and in the scientific, educational, and professional advancement of Mining Engineering.

Election of President.

By the unanimous wish of the Council, Dr. John Scott Haldane has consented to nomination for re-election as President for the ensuing year.

Roll of the Institution.

The number of members on the Roll of the Institution (that is, those whose subscriptions had been paid or guaranteed by the Federated Institutes at July 31st, 1926), was 3,140, as compared with 3,296 at July 31st, 1925, a decrease of 156.

The Council record with regret the decease of several members.

Empire Mining and Metallurgical Congress.

The Empire Council of Mining and Metallurgical Institutions, of which the Institution is one of the Constituent Bodies, have accepted an invitation conveyed through the Canadian Institute of Mining and Metallurgy to hold the second (triennial) Empire Mining and Metallugrical Congress in Canada in August-September, 1927.

The provisional programme embraces Sessions in Montreal (inaugural), Toronto, Winnipeg, and Vancouver, with visits to mines and works and places of scenic beauty throughout the Dominion.

The Empire Council have issued a notice of the Congress to members of the constituent institutions, and full particulars will be issued in a series of communications by the Canadian Organising Committee. The General Secretary of the Congress is Mr. George C. Mackenzie, whose address is Drummond Building, Montreal, Canada.

Accounts.

The Statement of Accounts shows the Income for the year ended July 31, 1926, to have been £6,049 6s. 8d., as compared with 6,378 18s. 6d. in the previous year, and the Expenditure £6,013 8s. 7d., as compared with £6,465 3s. 10d. in the previous year, the excess of Income over Expenditure being £35 18s. 1d., as compared with a deficit of £86 5s. 4d. in the previous year.

FARADAY SOCIETY.

The following paper was read at the meeting held on October 27, 1926 :—

Abnormal Absorption of Gases by Steel.

By T. Carlton Sutton, M.Sc., F.Inst.P., and H. R. Ambler, B.Sc., A.I.C.

Synopsis.

I. Steel, which has been exposed instantaneously to high pressures and temperatures, is found to absorb as much as 30 c.c. of gas per gram, that is to say, many times as much as is absorbed under the conditions of measurement hitherto recorded.

II. The gases so absorbed are retained firmly by the steel at temperatures below 600° C. Even on prolonged exhaustion at about 1,000° C., desorption is not complete.

III. The absorption of cubic centimetre of mixed gases is accompanied by an energy evolution of about three-quarters of a gram-colorie.

Introduction.

The research here described originated in some work on the calorimetry of high explosives. The explosives were confined in ¼-inch steel containers, suspended in a large closed vessel. When the mass of the products of explosion (gaseous and solid) was examined, it was found that the total amount of each of the elements in the explosive did not reappear in the measured products of the explosion. If these discrepancies were to be accounted for on the hypothesis of occlusion of some of the gaseous products in the steel-dust, which is formed when the container fragments, the absorptivity of the steel-dust, which have to be more than ten times greater than the highest value hitherto recorded.

Experiments were therefore put in hand to determine whether under the extreme conditions to which the steel is subjected this could possibly be the case. There now appears to be no doubt that the adsorptivity is actually many times greater than was supposed.

Sieverts has investigated the subject of absorption by metals at temperatures up to 1,600° C., and at pressures not exceeding 1½ atmospheres. He finds that soft iron may be made to take up hydrogen to the extent of 0.01 c.c. per gram of iron at 400° C., and 0.06 c.c. at 1,000° C., and that nitrogen may be absorbed to about three times this amount. Taylor and Burns obtain results of the same order. Absorption appears to increase approximately as the square root of the pressure.

Measurements have also been made of the amount of gas that can be withdrawn from various steels. Baker heated samples of steel *in vacuo* at high temperature for long periods. From some high carbon steels referred to as " sound " he was able to pump off as much as 1½ c.c. of gas per gram of steel. From other steel, however, smaller quantities of gas were removed, namely, about 0.5 c.c. per gram. Analysts obtain results which vary to about the same extent. Larger volumes amounting to several cubic centimetres per gram have been recorded by Donaldson. Alleman and

Darlington have recorded the slow evolution of large quantities of gas (up to 25 c.c. per gram) from a high carbon steel when heated to 1,500° C.; there is, however, some doubt as to the sources of the gas since interaction with the containing vessels was observed (*ibid.*, p. 469, 7, p. 472). It is to be noted that these large quantities are of the same order but not greater than those found in the present research.

Cases in which absorption is greater at high than low temperatures would require (in accordance with the van't Hoff isochore) that absorption of gas be accompanied by absorption of energy; according to the present measurements, however, absorption of gas is accompanied by evolution of energy (see section "Energy of Absorption"). The explanation of this is, no doubt, *inter alia*, that equilibrium has not been attained, and that the rate of absorption rather than the equilibrium constant has determined the amount absorbed. The rate increases rapidly with the temperature.

In an explosion, very high temperatures and pressures occur for a short period of time; both the rate of absorption into the surface and the rate of diffusion of the absorbed material into the interior of the steel particles are correspondingly high. It might be expected therefore that the quantity absorbed under these conditions would be great. The products of explosion cool with great rapidity and their pressure falls. Before desorption can take place to an appreciable extent, lower temperatures are regained, at which the velocity of desorption is negligibly small. The steel might be expected therefore to retain at ordinary temperatures and pressures much of the material absorbed during the explosion. This has now been found to be the case.

EXPERIMENTAL.

The measurements may be grouped under the three heads :—

(i) *Determination of the Gas Absorbed.*—The gaseous products produced when cordite is mixed with steel-dust and burnt in a closed vessel have been measured, analysed and compared with the products obtained when cordite is burnt alone.

(ii) *Determination of the Gas Desorbed.*—(*a*) The steel-dust obtained from (i) has been heated *in vacuo* at temperatures up to 1,000° C. The gas pumped off has been measured and analysed.

(*b*) Steel-dust taken from the residues produced by the detonation of a high explosive in cylindrical steel containers of ¼-inch wall, has been treated as in (*a*).

(iii) *Determination of the Energy of Absorption of the Gas.*—The vessel used in (i) is part of a standard calorimetric system. Consequently the heat evolved on firing mixtures of cordite and steel-dust could be measured and compared with that evolved when cordite was fired alone.

Absorption of Gas.—Some filings of mild steel were separated into three portions by means of sieves of 90 and of 140 mesh. They were then rendered grease-free by washing with ether.

Charges of 10.5 g. of cordite were then mixed with this steel-dust in the proportions detailed in Table I., and fired in a closed vessel of nickel-chromium steel of 105 c.c. capacity. The firing took place under water so that any leaks would have been detected. None were observed.

When the vessel had cooled, it was connected with an evacuated vessel of 17 litres capacity and the gas was allowed to pass quickly into the large vessel. From the temperature of the latter and the change in pressure, the volume of the dry gas was obtained. This was then compared with the volume when the cordite was fired alone.

THE SILVER MINING INDUSTRY IN CANADA, 1925.

Silver Mining is not a distinct industry in Canada, as silver is found only in association with other metals, such as lead and zinc, particularly in the West, with cobalt in Northern Ontario, and with lode and placer gold, copper and other metals in various localities. Industrial reviews concerning the production of silver must therefore be limited to a discussion on the sources of supply and to general statistics on each of the contributing sections of the mining industry. Silver-lead-zinc mining is a very important industry in British Columbia, the Yukon Territory, Quebec, and to a less extent in Ontario, whereas the mining of silver-cobalt ores is carried on in Canada only in the province of Ontario. While silver is the predominating metal in some ores of the silver-lead-zinc group there are other mines which yield an ore carrying lead and zinc in greater values so that the silver content is of secondar yimportance. Silver values are the governing features in the silver-cobalt ores of Ontario.

MINERALOGICAL SOCIETY.

Tuesday, January 18, at 5.30.—Dr. A. Brammall and Dr. H. F. Harwood : "The Temperature-range of Formation for Tourmaline, Rutile, Brookite, and Anatase in the Dartmoor Granite." – A. Russell : "Notice of an Occurrence of Niccolite and Ullmannite at the Settlingstones Mine, Fourstones, Northumberland; of Stichtite at the Island of Unst, Shetlands; and Serpierite at Ross Island Mine, Killarney, Co. Kerry, Ireland.

ON THE FATTY ACIDS OF COD LIVER OIL.

By Yoshiyuki Toyama.

A sample of cod liver oil prepared in Karafuto from *Gadus macroecephalus* Tileius gives the following properties :—

Sp. gr. ($d^{15°}_{4°}$)	...	0.9261
Acid value ...	...	0.55
Saponif. value	...	186.1
Iodine value (Wijs)	...	155.9
Refr. index ($n^{20°}_{D}$)	...	1.4781
Unsap. matter	...	1.28
Mixed fatty acids :		
Sp. gr. ($d^{30°}_{4°}$)	...	0.8945
Neutr. value	...	193.6
Saponif. value	...	194.0
Iodine value ...	...	163.2
Refr. index ($d^{30°}_{D}$)	...	1.4652
Ether insoluble bromides ...	...	41.16 %

The following conclusions are reached regarding the composition of the fatty acids :

1. The amount of saturated acids in the mixed fatty acids lies between about 10 and 15 per cent. Amongst the saturated acids, palmitic acid is preponderating. Myristic and stearic acids are present in a lesser amount. Neither saturated acids having less than 14 carbon atoms nor those having more than 18 carbon atoms are present in detectable quantities.

2. The acids of the oleic series contain zoomaric and oleic acids, an acid $C_{20}H_{38}O_2$ (possibly gadoleic acid of Bull) and cetoleic acid. Tetradecenic acid is not present in detectable quantities.

3. The acids more unsaturated than those of the oleic series consist chiefly of C_{20} and C_{22} acids, the latter being preponderating, and possibly also of small quantities of C_{13} acids. Amongst C_{18} acids, $C_{18}H_{28}O_2$ and $C_{18}H_{30}O_2$ seem to be present. Amongst C_{20} acids, $C_{20}H_{32}O_2$ seems to form the main constituent. C_{22} acids consist essentially of

C[illegible] acids consist essentially of C[illegible]H[illegible]O[illegible]

NOTICES OF BOOKS.

Explosive Reactions in Gaseous Media. A General Discussion held by the Faraday Society, June, 1926. Pp. 251-375. Price 10s.

The Faraday Society held a profitable discussion on explosive reactions in gaseous media during last June and in the present volume the papers and discussions are collected in a permanent form.

The subject was considered under two main heads : Part I. Explosive Reactions Considered Generally; Part II. Explosive Reactions Considered with Reference to Internal Combustion Engines.

In his introductory paper to Part I. Dr. Garner traced the factors operating in gaseous explosions. Their study commenced with Volta's discovery in 1777 that a mixture of hydrogen and air could be exploded by an electric spark. It was further studied by Cavendish but required an urgent industrial problem in the form of mine explosions before a comprehensive investigation of gaseous explosions was undertaken. Sir Humphry Davy's researches led to the introduction of the safety lamp, his work ranged over ignition and temperatures, limits of inflammability, effects of pressure and of diluents, the volume of gases produced by explosion, and included an attempt to evaluate the relative speeds of explosions. Actual measurements on the velocity of the explosion were not made until Bunsen found the rate at which a stream of an explosive gaseous mixture must be driven through a jet to prevent the flame passing back. The discovery of the detonation wave by Berthelot and Le Chatelier in 1881 introduced more exact measurements and formed the basis for Dixon's later work. From 1881 to 1903 much experimental work was done and such matters as the limits of inflammability, ignition temperatures, speeds of flame propagation, etc., have been fairly completely worked out.

Among the noteworthy contributions to the discussion was one by Professor W. P. Jorissen on the limits of inflammability and regions of reaction and inflammability. Dr. Jorissen's experimental work will be familiar to readers of the *Chemical News* from his recent articles on this subject in this Journal and in the *Chemisch Weekblad* and *Recueil des travaux chimiques des*

The following papers are included in the volume under review :—

" On the Ignition Point of Gases," by Prof. H. B. Dixon, Dr. J. Harwood, and W. F. Higgins.

" Radiation in Gaseous Explosions," by Prof. W. T. David.

" Ionisation in Gas Explosions," by Dr. S. W. Saunders and Dr. W. E. Garner.

" Ionisation and Gaseous Explosions " by Dr. S. C. Lind.

" The Explosion Wave in Cyanogen Mixtures and the Sp. Heats of Nitrogen," by Dr. C. Campbell and Professor Dixon.

" Investigations on Gaseous Explosions," by Dr. Garner and Dr. Saunders.

Sir Dugald Clerk gave the Introductory Survey of Explosive Reactions in Reference to Internal Combustion Engines, and many eminent authorities participated in the discussion.

The Consistence of Cement Pastes, Mortars and Concrete. Building Research Technical Paper No. 5 of the Department of Scientific and Industrial Research. Roy. 8vo., paper wpr., pp. VIII + 54, with 23 text figs., and 1 plate. Price 2s. net. Postage extra. H. M. Stationery Office.

Three conditions are of obvious importance in connection with the use of neat cement pastes, mortars or concretes; namely, ease of manipulation, strength and permeability. It is desirable, therefore, to be in a position to specify with some exactness the factors by which these conditions can be controlled. This is not an easy matter, either for laboratory work or for practical construction. The workability, for example, depends primarily on the amount of water added; but it is unsatisfactory simply to use percentage amounts of water as the criteria, since, apart from the possibility of the materials being initially moist, different materials require different amounts of water to give maximum strength, minimum permeability, or even a desired plasticity. The way out of the difficulty appears to lie in the study of consistence, *i.e.*, the general physical state of the material when rendered plastic by the addition of water.

To specify consistence—though it is not altogether ideal—is shown in the present paper by Mr. N. Davey, B.Sc., A.M.Inst.C.E., to furnish a fair basis for comparison; but it inovlves another difficulty. How shall consistence be specified and measured? And upon what other factors does consistence depend?

The British Engineering Standard Specification for Portland Cement has recognised the desirability of specifying the consistence to be used, but up to the present no definite standard method of measurement has been included. For neat cement pastes, the mixture is required to be " plastic "—a definition which leaves much to the personal judgment of the manipulator. For cement and sand mortars, a formula is specified which incorporates the amount of water judged necessary for the neat cement pastes.

FORTHCOMING EVENTS.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

Friday, January 14, at 5 p.m.—" Tintor elto," A public introductory lecture by Prof. T. Borenius (with lantern illustrations).

Monday, January 17, at 6.30 p.m.—" The Literary and Historical Study of the Bible : The Old Testament." First of a Course of University Extension Lectures by Miss M. S. West, B.D., B.A.

At 8.15 p.m.—" Little Plays by St. Francis." By Laurence Houseman. Produced by the College Dramatic Society. Tickets 12s., 5s. 9d., and 3s.

Tuesday, January 18, at 5.30 p.m.—" Acoustics of Buildings," by Dr. E. G. Richardson. Also on February 25 and March 1.)

Wednesday, January 19, at 3 p.m. Barlow Lectures on " Dante," by Dr. Camillo Pellizzi.

Thursday, January 20, at 5 p.m.—" The Biological Action of Light," by Dr. D. T. Harris. (Also on January 27 and February 3.)

ROYAL INSTITUTION OF GREAT BRITAIN.

Tuesdays, January 18 & 25, at 5.15 p.m.—" Smoke as Aerial Disperse Systems," by R. Whitfield Gray, O.B.E.

Thursdays, January 20 and 27, at 5.15 p.m.—" Romanesque and Early Pointed

Architecture in Spain," by J. R. Weaver, M.A.

Friday, January 21, at 9 p.m.—"Tyndall's Experiment on Magne-Crystallic Action," by Sir *William Bragg*, K.B.E., D.Sc., F.R.S.

THE INSTITUTION OF MINING ENGINEERS.

PRELIMINARY NOTICE OF ANNUAL GENERAL MEETING, WEDNESDAY, FEBRUARY 2, 1927.

The Thirty-Seventh Annual General Meeting of the Institution of Mining Engineers will be held, by the courtesy of the Council, at the House of the Institution of Mechanical Engineers, Storey's Gate, Westminster, on Wednesday, February 2, 1927, at 11 o'clock a.m.

It has been decided to hold a Dinner, chiefly of a social character, in the evening of the day of the Meeting, to which ladies may be invited, and it is intended to arrange a musical programme. The Dinner will be held at the Whitehall Rooms, Hotel Metropole (Whitehall Place Entrance), on Wednesday, February 2, at 7 for 7.30 p.m., and members who intend to be present are requested to make application for tickets for themselves and their guests (12s. 6d. each person, exclusive of wine), as early as possible.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Thursday, January 20, at 5.30 p.m.—P. Dunsheath, O.B.E., M.A., B.Sc.: "33,000-Volt Cables with Metal Sheathed Cores, with Special Reference to the S.L. Type."

Wireless Section.—Monday, January 10, at 7 p.m.—General Discussion.

Mersey and North Wales Centre at Laboratories of Applied Electricity, University, Liverpool.—Monday, January 10, at 7 p.m.—Prof. W. M. Thornton, O.B.E., D.Sc.: Faraday Lecture on "What is Electricity."

North-Eastern Centre, Armstrong College, Newcastle-on-Tyne.—G. F. Odell, B.Sc.: "An *Outline of the* Trunking Aspect of Automatic Telephones."

North-Midland Centre, at Hotel Metropole, Leeds.—Tuesday January 11.—J. R. Beard, M.Sc., and T. G. N. Haldane, B.A.: "The Design of City Distribution Systems."

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London, W.C.2.

ANNUAL DINNER AND REUNION.

The Annual Dinner and Reunion of the Institution will be held at the Hotel Cecil, Strand, London, W.C., on Thursday, 10 February, 1927 (7.15 for 7.45 p.m.), under the Presidency of Dr. W. H. Eccles, F.R.S., supported by the Council. (Evening Dress and Decorations.)

His Royal Highness The Prince of Wales, K.G., has kindly consented to honour the Institution by his presence at the Dinner.

In view of the inconvenience of having the waiters collecting money for wine bills during the speeches, it has been decided on this occasion to make an inclusive charge of £1 11s. 6d. per cover (inclusive of wines, cigars and gratuities to waiters.)

Applications must be received not later than Monday, 31st January, when the application list will be closed. Tickets will be allotted in the first place to members only, according to priority of application, but if after dealing with members' applications there should be any further accommodation available, tickets will be issued for friends (limited to one per member).

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

32,322.—British Dyestuffs Corporation, Ltd.—Manufacture of derivatives from ligninsulphonic acid. December 21st.

32,725.—Grouchkine, L.—Diidotrimethylamine product. December 24th.

32,493.—Synthetic Ammonia & Nitrates, Ltd.—Production of methanol, etc. December 23rd.

Specifications Published.

239,878.—Farbwerke Vorm. Meister, Lucius, & Bruning.—Process for improving decamphorated oil of turpentine.

242,620.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of vat dyestuffs of the isodibenzanthrone series.

262,958.—British Synthetics, Ltd., and Higgins, E. B.—Manufacture of intermediate products suitable for the preparation of azo-dyestuffs.

Abstract Published.

260,885.—Chrome alum.—I. G. Farbenindustry Akt.Ges., Frankfort-on-Main, Germany.

Solutions of chrome alum from which crystals are deposited rapidly are prepared by heating an acidified solution of chromium sulphate to 30-45° C., cooling after some hours to 38° C., adding the requisite quantity of potassium sulphate and cooling. On agitating the solution, crystals are rapidly deposited, and the remaining strongly acid liquor may be used again.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

CARIOCA.

474,974.—All goods in Class 1 which includes chemical substances prepared for use in medicine and pharmacy.—John Miller & Co. (Liverpool) Limited, 24, Chapel Street, Liverpool. December 29.

470,868.—Word "PYMSAND" in part-segment of a circle for medicinal preparations for human use, but not including medicinal preparations for the skin.—The Pharmacists' Mutual Supply Association Limited, Harlington Works, Kingsteignton Road, Newton Abbot. December 29th.

FOR SALE.

Baker Steel Roll Refiners.—Particulars to Box No. C. B. B., c/o *Chemical News* Offices, Merton House Salisbury Square, London, E.C.4.

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PATENT 208516

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INDEX TO VOL. 133.

The Index to Vol. 133 (July to December 1926) will be published next week and included with the usual issue dated 28th January, 1927.

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A COMPACT AND COMPREHENSIVE SERIES OF TABLES AND REACTIONS IN CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

(*Continued from Page 373, Vol. 133.*)

SOLUBILITY TABLE OF HYRDIDES.

LiH hyd		BH_3 ! B_2H_6 B_4H_{10} $B_{10}H_{11}$ B_6H_{12} All hyd.	CH_4 ! ! ! C_2H_6 ! ! ! C_2H_4 ! ! ! C_2H_2 ! ! !	NH_3 : : N_2H_4 : N_3H :	OH_2 O_2H_2	F_2H_2 : :
NaH hyd			SiH_4 hyd Si_2H_6 ! Si_2H_4 (?) Si_2H_2 ! ! !	PH_3 ! ! ! P_2H_4 P_4H_2 $P_{12}H_6$	SH_2 ! ! ! S_2H_2 hyd S_3H_2 hyd S_5H_2 hyd	ClH ! !
KH hyd	**CaH_2 hyd**	Not known but $Ti(NH_2)_4$				
CuH ! ! ! CuH_2 ! ! !			GeH_4 ! ! ! Not analysed	AsH_3	SeH_2 ! !	**BrH : : :**
RbH hyd	SrH_2 hyd SrH hyd		ZrH_4 ! ! !	CbH_3 ! ! !		
			SnH_4 ! ! !	SbH ! ! !	**TeH_2 !**	**IH : :**

CsH hyd	BaH_2 hyd	LaH_3 hyd	Ce_2H_4 hyd			
			PrH_3 hyd			
			NdH_3 hyd			
				ThH_4 ! ! !		
				Not		
				hydrolysed		

Very few hydrides are stable compounds, and nearly all hydrolyse readily. Stability increases as we proceed towards fluorine. With the exception of the first the boron hydrides decompose easily, whereas hydrogen fluoride is exceedingly stable as also the hydrides next do to it water and hydrochloric acid.

The hydrides of carbon are almost infinite and their number is added to from time to time ,and this is remarkable, for carbon shows no such appetite for any other element, and both carbon and hydrogen are decidely neutral elements. Although ammonia is accounted basic on account of the high percentage of a supposedly metallic hydrogen, yet carbon one step to the end of the table nearer than nitrogen does not exhibit any basic qualities with hydrogen like ammonia.

NITRIDES, PHOSPHIDES, ETC.

H_3N : :, H_4N_2 :, HN_3 :, xxx, H_3P ! ! !, H_4P_2 ! ! !, H_3As ! ! !, H_4As_2 ! ! !

Li_3N hyd	Be_3N_2 hyd	BN ! ! !	C_2N_2 ! ! !	N_5P_3 hyd	O_5N_2 : :	F_3Nxxx
LiN hyd		Bn_3H_6	C_xN_x ! ! !		O_4N_2 hyd	F_5P hyd
LiN_3 : :		B_2NH_3	C_4N_2		O_3N_2 hyd	F_3P hyd
		$B_2N_3H_3$	C_6N_2		ON ! ! !	F_5As :
		BP ! ! !			ON_2 ! ! !	F_3As : hy
		B_5P_3 ! ! !			O_5P_2 : : :	
					O_4P_2 :	
					O_6P_4 !	
					OP_2 hyd	
					OP_4 hyd	
					O_5As_2 : :	
					O_4As_2 !	
					O_3As_2 :	
					OAs_2 ! ! !	

The nitrides in the middle of the table that is of boron and carbon are most stable. These are close neighbours to nitrogen. It would then appear a weak base takes more kindly to a weak negative element than to a strong one.

NaH_2N hyd	Mg_3N_2 hyd	AlN hyd	SiN ! ! !	P_3N_5 hyd	S_5P_2 hyd	Cl_3Nxxx
NaN_3 : :	Mg_3P_2 hyd	Al_3P	Si_3N_4 ! ! !	P_4	S_7P_4 hyd	Cl_5P
NaP_5 hyd	Mg_3As_2 hy	$AlAs_x$	Si_2N_3 ! ! !	PAs hyd	S_3P_2 hyd	Cl_3P·
NaH_2P		Al_3P_7	$SiHN$ hyd		S_3P_4 ! ! !	Cl_4P_2
Na_3As		Al_5P_3	Si_2N_3Hhy		SP_4(?)	Cl_5As
Both hyd		Al_2P	SiN_2H_2hy		S_5As_2 ! ! !	Cl_3As
		All hyd			S_3As_2 ! ! !	All hyd
					S_2As_2 ! ! !	
					SAs_3 ! ! !	

Note that the most stable nitrides are again those of the fourth group.

K_2N hyd	Ca_3N_2 ! ! !	Not known	TiN ! ! !	V_2N ! ! !	CrN ! ! !	Mn_3N_2 ! ! !
KN_3 : :	CaP hyd		Ti_3N_4	VN ! ! !	CrP ! ! !	Mn_3P_2 ! ! !
K_3P hyd	Ca_3As_2		TiN_4H_8	VN_2 ! ! !	$CrAs$! ! !	$MnSb$! ! !
KP_5 hyd	hydrol		TiP			$MnBi$! ! !
K_3As hy			All ! ! !			

Note that the nitrides of vanadium, titanium, and chromium are exceedingly stable, resisting the strong acids even on warming, and that these elements are not at all strong bases.

Cu_6N hyd CuN_3 !!! CuN_6 !! Cu_2NH hy Cu_6P_2 hyd Cu_3P_2 hyd Cu_6As hy Cu_3As hy Cu_5As_2 hy	Zn_3N_2 hyd ZnN_2H_4 ZnP ZnSb All hyd	**Not known**	Not known	AsN hyd AsP As_4 AsN_3H_6	Se_5P_2 Se_3P_2 Se_3P_4 SeP_2 SeP_4 All hyd	Br_2NP !!!
Rb_3N(?) $RbNH_2$xxx Rb_2P_5 Both hyd RbN_3 : : :	Sr_3N_2 hyd SrN_2H_4 SrN_6 : : Sr_3P_2 Sr_3As_2 All hyd	**Unknown**	Zr_2N_3 !!! Zr_3N_8 !!!	Cb_3N_5 !!!	Mo_5N_3 !!! Mo_5N_4 !!! Mo_3N_2 !!! Mo_2P_2 !!!	

The nitrides of zirconium, columbium and molybdenum are not attacked by acids.

Ag_3Nxxx Ag_4P_6 !!! Ag_2P_4 !!! Ag_2P_5 !!!	CdN_6 !!! CdN_2H_4 hy Cd_3P_2 !!! Cd_3As_2 !!!	InN	Sn_3P_2 hyd SnP hyd Sn_3As_2 Sn_4As_3 SnAs All hyd	SbN !!! SbP !!! Sb_2As	TeN !!! TeSb !!!	
$CsNH_2$ hyd $CsNH_3$: : :	Ba_3N_2 hyd BaN_6 : : BaN_2H_4 BaN_6H_{18} xxx hyd BaP_2 hyd Ba_3As_2 hyd	LaN hyd PrN hyd NdN hyd	CeN hyd	TaN !!! Ta_3N_5 !!!	W_2N_3 !!! W_2P !!! WP xx W_3P_4 !!! WP_2 !!!	

Tantalum *and tungsten* nitrides are stable, insoluble in acids.

Au_4P_6 hyd AuAs hyd Au_3Sb !!! Au_3Bi !!!	Hg_3N_2 hyd HgN_3 !!! HgN_6 : Hg_3P_2 !!! Hg_3P_4 !!!	TlN_x xx TlN_3 ! Tln_6xxx Tl_3P Tl_3As TlAs hyd Tl_3Sb	PbNH hyd PbN_6 !!! PbP_5 hyd	BiN xxx hydrol BiP hyd Bi_3As_4 hy		
			Th_3N_4 hyd ThP_x		U_3N_4 hyd U_3P_4 hyd U_3As_4 hyd	

Unlike their cogeners these compounds are not stable in the presence of water.

Fe_2N (magnetic) !!!, Fe_3N_2 !!!, FeN !!!, Fe_3P, Fe_2P, Fe_2P_3, FeP_x, all !!! and stable; Fe_2As !!!, Fe_2As_3 !!!, $FeAs_2$!!!, Co_2N, Co_3N_2, Co_3P_2, Co_4P_3, Co_2P, CoP, $CoAs_3$, all !!!; Ni_3N_2, Ni_5P_2, Ni_3P_2, Ni_2P, Ni_2P_3, NiP_2, NiP, all !!! and stable; Ni_3As_2 !!!, PtP_2 !!!, $PtAs_2$!!!

THE DENSITIES OF CERTAIN BINARY LIQUID MIXTURES AT 25° C.

By R. M. WOODMAN.
(*School of Agriculture, University of Cambridge.*)

In the following tables are presented values obtained for the densities of certain binary liquid mixtures at 25° C., compared with water at 4° C.; many of these values —necessary to the author for various purposes—have had to be determined owing to the scarcity of such information in modern tables of data. A record is made here in the hope that it may be of use in future investigations.

The liquids used were purified in the usual manner. The mixtures were made up at room temperature by weight in a weighing bottle fitted with an air-tight, ground, outer stopper; the determinations were carried out in a small pyknometer capable of suspension in the thermostat.

All weighings were performed by the method of swings on a sensitive Göckel balance whose sensitivity—greater than three scale divisions per mg. at all loads used—had been determined over a long range, a system of mirrors, lenses and two scales being fixed to the balance to magnify the scale and avoid parallax. The weights used were calibrated on this balance by double weighings.

The densities were corrected for the bouyancy of air by the usual approximation formula (*Dictionary of Applied Physics*, 1923, 3, 127; Findlay, *Practical Physical Chemistry*, 1920, 43).

The first columns of the accompanying tables give the weight-percentages (gm. per 100 gm. of mixture) of the first-mentioned constituent of the mixtures; the second columns represent the corrected densities of the mixtures at 25° C., compared with water at 4° C.

Acetic Acid —	Water Mixtures
0.00	0.99707
15.35	1,0180
21.20	1.0252
28.38	1.0337
36.77	1.0425
43.41	1.0484
50.49	1.0541
58.02	1.0589
67.08	1.0635
83.45	1.0659
94.59	1.0560
100.00	1.0450

Pyridine —	Water Mixtures
6.917	0.88087
15.79	0.89027
21.72	0.89633
25.53	0.90024
29.77	0.90449
49.58	0.92523

Acetic Acid —	Toluene Mixtures
0.00	0.85980
9.889	0.87293
16.44	0.88185
31.64	0.90397
41.79	0.92052
49.61	0.93408

Acetic Acid —	Benzene Mixtures
11.52	0.88707
15.46	0.89168
23.64	0.90185
28.60	0.90862

Phenol —	Water Mixtures
1.370	0.99807
1.676	0.99827
3.523	0.99964
4.577	1.0006

Phenol —	Benzene Mixtures
0.00	0.87373
81.75	1.0224
100.00	1.0598

THE QUANTUM THEORY.

If the hypothetical medium, ether, consists of discrete particles, which are imimpenetrable, and have a diameter equal to the minimum orbital radius of an electron, we should get the orbits of the latter limited as required by the quantum theory.

A. W. WARRINGTON.

PRODUCTION OF ALUMINA FROM ALUNITE.

By JINGORO YAMAZAKI AND JINROKU FURUFAWA.
(*Journal of the Society of Chemical Industry, Japan.*)

In the present experiments the authors have treated alunite by sulphurous acid, and easily separated all the components of alunite, and have most economically produced pure alumina necessary for manufacturing aluminium, and potassium sulphate. The natural alunite is a hydrous basic sulphate of potassium and aluminium (*i.e.*, $K_2O.3\ Al_2O_3.4SO_3.6H_2O$).

1. In order to dissolve alunit by sulphurous acid treatment, it is the most suitable process to carry out the experiments at 65° C. with alunite ignited at 550° C. and water; the proportion of alunite and water being 1 to 10; then over 90% of alunite are dissolved.

2. The clear solution thus obtained contains $Al_2(SO_4)_3.K_2SO_4$ and $Al_2(SO_3)_3$. When it is heated at 110° C. simply, sulphurous acid gas evolves out, and in its early stage it is thrown down as basic aluminium sulphite with the composition of $5Al_2O_3.3SO_2.15H_2O$, but when it is heated long the whole aluminium in the solution is precipitated as a compound of $5Al_2O_3.3SO_2.2\{K_2SO_4.Al(SO_4)_3\}24H_2O$; therefore it has been proved that the separation of alumina and alkali is impossible.

3. By adding the equivalent weight of ammonium sulphite or calcium sulphite to aluminium sulphate in the said solution and by heating at 110° C., over 94% of the alumina is thrown down as basic aluminium sulphite ($5Al_2O_3.3SO_2.15H_2O$) in an easily filterable form, and also we have obtained ammonium sulphate and potassium sulphate from the solution.

4. After drying basic aluminium sulphate obtained as above described, it is subjected to heating at high temperature and then its decomposition begins with the evolution of SO_2 at 800° C., and it has been assured that it is transformed into pure alumina at over 900° C. The alumina thus obtained contains Al_2O_3 99.65%; Fe_2O_3 0.09%; SiO_2 0.24%.

ON THE STUDY OF THE PRODUCTION OF PURE ALUMINIUM IN THE ALUMINIUM INDUSTRY FROM INSOLUBLE ALUMINOUS MATERIALS SUCH AS CLAY OR ALUNITE.

By Jingoro Yamazaki.

(*Journal of the Society of Chemical Industry, Japan.*)

1. The raw materials we made use of in the present study are Japanese clay and Korean alunite. These materials become nearly insoluble in sulphuric acid, and easily soluble in consequence of ignition. The most suitable ignition temperature is 700°-800° C. in the case of the clay, and 550° C. in the case of alunite; and over 95% of alumina are dissolved in dilute sulphuric acid.

2. The clear solution obtained by the above described process contains aluminium sulphate, iron sulphate and others. When the sufficient quantity of ammonium sulphate is added to convert the whole of aluminium to alum and is allowed to crystallise ,iron salt remains in the solution.

3. Aluminium hydroxide and ammonium sulphate are produced by the direct action of crystal alum obtained as above described and dry ammonia gas. The most suitable temperature in this case is 75° C. The aluminium hydroxide thus prepared is compact granular particles and is easily to be filtered and washed, and pure aluminium hydroxide is produced by water extraction.

4. The comparison between aluminium hydroxide obtained as above described and the one prepared by Bayer process shows that the two have almost the equal volume; the molecular formula of the former being $Al_2O_3.2H_2O$.

5. The authors carried out the production experiments on the semi-technical scale with a successful result.

CAUSTICISATION OF SODIUM CARBONATE BY FERRIC OXIDE. IV. DECOMPOSITION PRESSURES OF Na_2CO_3 IN THE PRESENCE OF Fe_2O_3 AND DYNAMICAL ESTIMATION.

By Mototaro Matsui & Hisayuki Mitsui.

(*Journal of the Society of Chemical Industry, Japan.*)

Mixtures of 1 part Na_2CO_3 and 1.8 parts Fe_2O_3 were heated from 500° to 850° C. in a quartz tube furnace (and CO_2 expelled by air transpiration was corrected in KOH bulbs. The experimental results were as follows :

1. Decomposition pressures were measured dynamically.

2. Pressures by the dynamical method were much smaller than those obtained statically (Second Report, by Matsui and Kochi). These phenomena were fairly identical with the case of $Fe_2(SO_4)_3$ (Keppeler and D'Ans, Wöhler, Bodenstein and Suzuki).

3. Dynamical pressures were found similar to statical pressures that appeared in sight at the beginning.

4. Dynamical estimation for decomposition pressure is not preferable in the case of the slow reaction rate.

December, 1925.

Technical Chemical Laboratory,
Waseda University.

ON THE REACTION BETWEEN SODIUM PHOSPHATES AND CALCIUM HYDROXIDE.

By Hiroaki Hayashi & Mototaro Matsui.

The present investigation has been done in connection with the previous article : On the treatment of aluminium phosphate rock by caustic soda solution.

Summary.

1. The reaction between sodium phosphates and calcium hydroxide became more intense according to higher temperature and longer time.

2. At 90° C. and for 1.5 hours, quantity of $Ca(OH)_2$ to precipitate total phosphoric acid was 137.5%.

3. For the temperature intervals of 70°-90° C., the quantity of $Ca(OH)_2$ would remain constant, but at lower temperature more would be needed.

4. The action of sodium triphosphate might be stronger than that of sodium diphosphate because of unsteadiness, and lime quantity was almost constant until 20% free alkali.

5. Much lime ought to be added to 150% dilution of sodium phosphates solution (20 gr. $Na_2HPO_4.12H_2O$ per 132.9 c.c.).

6. Comparing actions of quick lime, slaked lime and weathered lime quick lime was found best and slaked lime next.

7. The grains of lime passing through the sieves of 90 to 150 meshes showed the same result.

8. In the presence of other sodium salts, the reaction would be retarded because of increasing solubility of calcium phosphate formed.

December, 1925.

Technical Chemical Laboratory,
Waseda University.

ON THE COMPOSITION OF HERRING OIL. I. SATURATED ACIDS AND ACIDS OF THE OLEIC SERIES OF "O-NISHIN" OIL (GREAT HERRING OIL).

By Mitsumaru Tsujimoto.

Among the fish oils produced in Japan, herring oil occupies the most prominent position, as its annual production of 200,000-300,000 " hako " far exceeds those of other fish oils (1 " hako " contains about 33 kg. of the oil). There are two kinds of hering oil in Japan (*viz.*, oils from " O-nishin " (great herring) and " Ko-nishin " (small herring), the former being produced in much larger quantity. The somple of "O-nishin" oil used for this experiment was procured from Hokkaido. It had the following properties :

Sp. gr. (15°/4°)	0.9167
Acid value	6.53
Saponif. value	185.0
Iodine value	100.0
Ref. Index (15°)	1.4731
Hehner value	95.4
Reichert-Meissl value	0.73
Unsap. matter (%)	1.01

Thus the iodine value of " O-nishin " oil is low, being usually lower than 120, and in this respect it differs from foreign herring oils.

The author has investigated the saturated acids and the acids of the oleic series of " O-nishin ' 'oil, and arrived at the following conclusion :

(1) From the saturated acids (ca. 19% of the total acids) palmitic and myristic acids were isolated, the former forming the main constituent. Stearic acid and higher saturated acids seem to be present in far smaller quantities.

(2) The unsaturated acids consist mainly of the acids of the oleic series (probably up to 80%). The following four acids have been identified.

$C_{16}H_{30}O_2$ (Zoomaric acid ?).
$C_{18}H_{33}O_2$ (Probably ordinary oleic acid).
$C_{20}H_{38}O_2$ (Gadoleic acid ?).
$C_{22}H_{42}O_2$ (Probably identical with Toyama's cetoleic acid).

(3) The acids of the oleic series appear to be of straight-chain carbon compounds, as evidenced by their hydrogenated products.

(4) A great importance may be attached to the fact that there occurs in " O-nishin " oil remarkable amount of C_{20} and C_{22} acids of the oleic series. Their amount attains probably to about 30-40% of the total fatty acids.

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General Notes.

CANADIAN MINERAL FIGURES FOR 1926.

The preliminary estimate of the Dominion Bureau of Statistics places the output of the Canadian mineral industries for 1926 at 242,886,000 dollars, which is 7.1 per cent. above the previous year and 16,000,000

dollars above the previous highest year—1920. The output of non-metallic minerals, excluding coal, increased 10 per cent., to 24,841,000 dollars and that of coal 3,000,000 tons to 16,000,000 tons with a total value of 58,000,000 dollars, which is 18 per cent. above the value of last year's output. The production of metals rose 2,500,000 dollars to 119,881,000 dollars. Gold production remained practically stationary at 1,729,377 fine ounces, silver rose 1,500,000 fine ounces to 21,907,000, nickel fell 6,250,000 lbs. to 67,551,000 lbs., copper rose 28,000,000 lbs. to 139,000,000, lead rose 28,000,000 lbs. to 281,000,000, and zinc rose 38,000,000 lbs. to 148,000,000 lbs.

With reference to London Press statements that alleged American share-pushers are contemplating a house-to-house campaign in this country to dispose of shares in a number of bogus Canadian gold and silver mines and oil wells, it should be made known that the Canadian authorities, either in Canada or in London, have no definite knowledge of such activities, of which they strongly disapprove, not only on account of the loss to individuals of hardly-won savings, but because the good name of the Canadian mining industry is being jeopardised.

There is in Canada a great and increasing demand for capital in mining enterprises, and a keen desire that British capital in particular should participate in the developments which are taking place on a great and ever-increasing scale.

The fact that Canada has been chosen as the scene of the 1927 Session of the Empire Mining and Metallurgical Congress and of the British Association for the Advancement of Science in 1930, is evidence of the efforts which are being made by British and Canadian mining engineers and financiers to "get together" to further progress in this great field of development.

Cautions have, nevertheless, repeatedly been issued by the Canadian Ministers of Mines, both Federal and Provincial, and by the High Commissioner in London, against the purchase of Canadian stocks from irresponsible parties without proper investigation. Investors have consistently been advised to do all transactions of this nature through their own bankers or through a recognised British Stock Exchange.

The injunction to caution thus offered is perhaps more applicable to mining propositions as, while the rewards to the successful are rich—in Canada as elsewhere—the risks undertaken are also great.

ANTIQUITY OF SILVER MINING IN CANADA.

Silver in Canada.

Silver production in Canada dates back many years, the earliest account being that of the finding of argentiferous-lead on the Quebec side of Lake Temiskaming about 1686; it is somewhat remarkable that the cobalt area lying within a short distance of this property, and now one of the richest silver camps in the world, was not known until 1903. In 1868, Thomas McFarlane, working on a rock about 80 or 90 feet in diameter, off Thunder Cape in Lake Superior, discovered a vein containing galena and silver, which was afterwards worked as the Silver Islet mine; this property yielded about 3.5 million dollars' worth of silver before it was flooded by the waters of the lake. Then in 1903 the next big find was made. Long Lake, later called "Cobalt Lake," was the centre of the area which became known as the "Cobalt-Silver Camp." This camp and the allied camps of Gowganda and South Lorrain, have been in continuous operation since that time and at the end of 1925 had yielded upwards of 364 million ounces of silver.

Sources of Silver, Lead, Zinc and Cobalt.

In 1925 the total production of silver from Canadian ores of all kinds, amounted to 20,228,988 fine ounces and included (a) silver contained in silver and gold bullion produced, 10,219,359 fine ounces, of 50.5 per cent. of the total, (b) silver contained in blister copper or lead bullion made, 6,179,238 fine ounces or 30.5 per cent., and (c) silver estimated as recoverable from ores of all kinds exported for treatment in foreign smelters, 3,830,391 fine ounces or 19 per cent.

The production of lead during the same year amounted to 253,590,578 pounds, an advance of 44.5 per cent. above the previous high record of 175,485,499 pounds set up in 1924 .

CANADIAN MINERAL PRODUCTION.

The Canadian official mineral production report states that Canada's mineral industries yielded a new record during 1926, the value of the production reaching a total of 242,886,000 dollars, which is 7.1 per cent. above the preceding year. The previous highest mineral output was 227,859,000 dollars, established in 1920.

Metal mining advanced steadily throughout the year, the production of copper, lead and zinc reaching new records. Silver was above the previous year, gold remained steady, while nickel showed a slight decline. Non-metallic minerals, excluding coal, were up 10 per cent. to 24,841,000 dollars. Asbestos mines had a profitable year owing to the formation of a merger, although the output declined slightly. The gypsum production was up with a good export demand. The production of crude petroleum, talc, coapstone, feldspar, graphite, magnesite, pyrites and sodium sulphate showed increases, while the output of sodium carbonate, mineral waters, iron odeides, grindstones, barytes and bituminous sands, was well maintained.

The value of the production by the three main groups is as follows:— metals, 119,881,000 dollars, against 117,028,000 dollars in the previous year; non-metallic minerals, including coal, 83,005,000 dollars, against 71,851,000 dollars in the previous year; structural materials and clay products, 40,000,000 dollars, against 37,649,000 in the previous year.

The production of metals is as follows:— gold down 6,358 to 1,729,377 fine ounces; silver up 1,678,508 to 21,907,496 fine ounces; nickel down 6,305,000 to 67,551,000 lbs.; copper up 28,000,000 to 139,000,000 lbs.; lead up 28,000,000 to 281,000,000; zinc up 38,000,000 to 148,000,000 lbs.

The production of the principal non-metallic minerals and building materials was as follows:— Coal up 2,870,000 to 16,105,000 tons; asbestos down 18,000 tons to 272,000 tons; natural gas up 1,673 million cubic feet to 18,576 million cubic feet; gypsum up 50,000 to 790,000 tons; crude petroleum up 7,000 to 339,000 barrels; salt up 11,000 to 245,000 tons; cement up 499,000 to 8,615,000 barrels.

IMPERIAL CHEMICAL INDUSTRIES, LIMITED.

An interesting volume describes the activities of the constituent companies forming the above great Corporation. An introduction to the volume has been written by The Right Hon. Sir Alfred Mond, Bt., M.P.

It gives me great pleasure (he says), to take this opportunity of writing a brief outline of the history and activities of the four constituent companies, Brunner, Mond and Co., Ltd.; Nobel Industries, Ltd.; The United Alkali Co., Ltd., and British Dyestuffs Corporation, Ltd., which have been amalgamated in Imperial Chemical Industries, Ltd.

For mergers of such great magnitude are not merely of financial or commercial interest. They have a wider national and imperial aspect. The formation of great combinations in other countries caused the leaders of the chemical industry in this country to consider the relative position of their individual concerns and of the industry as a whole. After very careful consideration of all the relative circumstances, they came to the conclusion that the time had arrived for the British and Imperial Chemical Industry to endeavour to form equally a united front.

Strong as the units of the combination were and capable as they were of operating in the future, as in the past, with profit to their shareholders and with benefit to the country, it was felt that by union still greater efficiency, both commercially and technically, could be obtained for the development of existing and creation of new chemical industries, with the great advantage of saving any unnecessary expenditure of capital by duplication and overlapping. The constituent companies operate not only in this country, but throughout the Empire and the markets of the world. They were already related not only as producers but also as consumers of each other's products. The great advantage to be gained, from as close and intimate a relationship as it was possible to create, was therefore felt by all concerned.

The formation of Imperial Chemical Industries, Limited, will enable the British Chemical Industry to deal with similar large groups in other countries on terms of equality. It will enable the industry to speak with a united voice. Instead of leaving it to individual units to make arrangements for the world's competitive conditions as best they can, Imperial Chemical Industries will give them all the authority, prestige and advantages of a great combination.

To-day capital expenditure on modern chemical plant runs into many millions of pounds. Specialisation of products, the most efficient use of capital and of technical processes therefore became a vital factor to success, not only in the chemical industry, but throughout all modern industries.

Modern mergers when managed by able business men are not made for the purpose

of creating monopolies or of inflating prices. Fusions are formed for the purpose of realising the best economic results which both capital and labour will share to the best advantage. They enable varieties of industries to form an insurance against fluctuations of markets and prices in individual products. In fact, both for the shareholder and the worker, fusion acts as a form of insurance against those risks in industry which are inherent and cannot be avoided, even the most skilful management.

The chemical industry of Great Britain has always been one of its leading features. In past days, Great Britain has produced as large, if not larger, a body of courageous and scientific inventors in the realm of chemical industries, as any other country. This is a fact which is often too little appreciated. To-day, British technologists are competent to deal with any and all of the new and intricate problems which confront them. In many respects there never was an era when the future of the chemical industry in so many new directions showed such striking possibilities. A combination such as has been formed, having at its command capital, management and research to enable it to finance, develop and explore all the new potentialities should be in a position second to none to keep the country and the Empire in the first and foremost rank of an industry which is essential for the national safety and fundamentally the basis of a vast superstructure of other industries depending upon its products. For chemicals form the foundations of industries.

The relationship between the co-partners in the chemical industry has had a fortunate and happy history. Those who in the past have conducted the industry have always regarded all those working with them in any capacity as fellow-workers in a common cause. The foundation of Imperial Chemical Industries, Limited, will not alter that close personal contact which has happily existed for more than one generation between the captains and their companies of men. The goodwill of all those engaged in the industry is one of the most valuable of assets, and this is fuly recognised by those who will control the future destiny of the chemical industry of Britain and the Empire.

THE IONIZATION OF OXYGEN BY ELECTRON IMPACT AS INTERPRETED BY POSITIVE RAY ANALYSIS.

By T. R. Hogness and E. G. Lunn.

(Abstract, *Physical Review.*)

Using an apparatus previously described in which ions formed by impact of electrons of definite energy are analysed by Dempster's positive ray method, the relative numbers of O_1+ and O_2+ are measured at different pressures and electron energies. Over a range of pressure from $<10^{-5}$ to 10^{-2} mm. of mercury in pure oxygen, and over a large range of partial pressures of oxygen in mixtures with helium and with argon, the ratio O_2+/O_1+ remains practically constant. Evidence is thus given that O_2+ and O_1+ are formed by independent primary processes and, therefore, that an impact electron of sufficient energy can either ionize the molecule and form O_2+ or dissociate the molecule forming O_1+. The ionization potentials were determined: $O_2 = O_2+ + \epsilon$; 13 volts and $O_2 = O_1+ + O + \epsilon$; 20 volts The latter, together with the ionizing potential of atomic oxygen, gives 6.5 volts (150,000 cal. per mol) for the heat of dissociation of oxygen. Both molecular and atomic negative ions were found. The above results are correlated with band-spectra data, with the recent theory of Franck on dissociation by absorption of radiation, and with the structure of the oxygen molecule.

Discussion.

The ionization of oxygen has been studied by McIlenry and by Smyth. McHenry used Thomson's positive-ray apparatus and hence experimental conditions that make difficult any comparison of his results with those above. The present results differ somewhat from those of Smyth. His published curves show a larger percentage of O_1+ than was found above; this is perhaps due to the presence of N_1+ and other impurities not resolved by his apparatus. The ion of apparent $m/e = 8$, which Smyth observed, was probably not $O++$. In the present work its peak appeared as a very broad one of small height—indicative of formation by some secondary process, such as the disruption of an O_2+-ion which had fallen through the full analyzing field. The above experiments show no evidence of the discontinuity in the ionization curves at 450 volts found by Smyth. His measurements gave 15.5 and 23.0 volts as the ionization potentials. We believe Smyth's values for these ioniza-

tion potentials to be in error, owing, perhaps, to incorrect initial velocity corrections; but their difference (23.0 - 15.5 = 7.5 volts) agrees well with that (7 volts) found above.

Of the several determinations of the ionizing potentials of oxygen only that of Mackay shows ionization at low as 13 volts; he found two potentials at 12.5 and 16.1 volts. Studying low voltage arcs in oxygen, Lockrow and Duffendack found critical potentials at 16.1 and 19.5 volts. The lower, that at which the arc broke, they ascribed to the formation of O_2+; the upper, a critical potential for changes in the spectrum, was attributed to the formation of O_1+ by the process $O_2 = O_1+ + O + e$. The lower potentnal of Mackay and the upper one of Lockrow and Duffendack are thus in good agreement with those found above for the formation of O_2+ and of O_1+ respectively.

THE CHEMIKER ZEITUNG'S JUBILEE.

The Chemical News was founded in 1859 by the late Sir William Crookes and celebrated its Jubilee in 1909. Soon afterwards there was published the *General Index* to the first 100 volumes, which contained the British record of the progress of chemical science during those fifty years.

On December 4, 1876, there appeared the first (specimen) number of the German " Chemical News, the *Chemiker Zeitung*, and from January, 1877, it has appeared regularly. So well organised is the German chemical industry that this journal which now celebrates its jubilee can appear thrice weeekly.

The special *Jubilee Number* contains many congratulatory messages from all over the world (except England—Prof. H. E. Armstrong, however, contributed to the succeeding issue), and Prof. W. Roth, who had edited the *Chemiker Zeitung* for many years, gives its history.

In addition, the following noteworthy artcicles appear in the same number :—

Prof. Wilhelm Ostwald : " The Future of German Chemistry."

Prof. P. Walden : " Fifty Years of Theoretical Electrochemistry."

Prof. W. Ipatiew : " The Allotropic Modifications of Phosphorus."

Dr. Auer von Welsbach : "Element Number 61."

Prof. D. Holde : " Fatty Acid Anhydrides."

Dr. J. Bueb : " German's Nitrogen Industry."

Dr. F. Hofmann : " Where Stands Synthetic Rubber." Etc.

SOUTH AFRICAN CHEMICAL INSTITUTE.

At the recent annual meeting it was reported that the membership numbered 148.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

" Wireless in the Empire."

(*Abstract of an address by* W. H. Eccles, D.Sc., F.R.S., M.R.I., *Vice-Chairman, Wireless Telegraphy Commission.*)

Friday, April 30, 1926.

The British Empire is a medley of fragments spread as if by blind chance over the habitable portions of the globe. Looked at in Mercator's projection, it is like a broken potsherd on the floor—a collection of large and small pieces, at all distances apart.

For so dispersed a family the problem of telegraphic communication is important and difficult. Until the year 1902 long-distance telegrams were all carried by cables, under the sea or under the ground, and by wires on poles; and the task of serving sparsely populated and distant regions required capital outlay beyond reason. But between 1902 and 1904, in a series of bold experiments, Marconi proved that messages could be conveyed thousands of miles by telegraphy without wires. Then he and many others showed that electric waves could pass over mountain chains, and even far round the bend of the globe, at any rate at night, and that they could be picked up simultaneously in all directions round their source. Here, obviously, was a heaven-sent gift to the British Empire, for by wireless telegraphy we might now hope to communicate, simultaneously if desired, with a thousand places to which cables and wires could never be run. The progress made in the utilisation of this gift of science is the subject of my discourse this evening.

In 1912 Parliament approved a contract which the Post Office had made with the Marconi Company for the erection of an Imperial chain of six stations. This contract was, however modified after a technical enquiry, and a new contract was rati-

fied by the House of Commons in 1913. But the engineers had barely time to erect a few masts at Leafield in Oxfordshire and at Abu Zabal near Cairo, when the contract was dissolved, principally because of the advent of war. In contrast with our inaction, the United States had meanwhile pressed on with the construction of several large government stations, and France, and Germany made great progress with their respective colonial plans. Perhaps we could afford to delay. Compared with Germany, for instance, we possessed elaborate cable communications, and were more confident about defending them in every sea than Germany could be. But the result was that when war broke out in August, 1914, no unit of the much-discussed wireless chain had been erected.

Germany, on the contrary, had made great strides with her colonial communications between the years 1912 and 1914. She had established thoronghly modern stations in Togoland, in German East Africa, in German South-West Africa, and in the Pacific. The three African stations could inter-communicate with one another, and, to a limited extent, with the great station at Nauen, near Berlin. The Pacific station was at Yap in the Caroline Islands. It was a noteworthy coincidence that all these stations were completed just before the war began. I remember hearing the early trial signals from Yap while I was sailing across the Pacific in July, 1914. No doubt this station was intended to receive instructions from Berlin, and re-transmit them to island possessions, such as Apia in Samoa, and to naval and mercantile vessels in the Pacific and the China Seas. It may be of interest to recall the fate of the Yap; it is wrapped up with the story of the German Pacific Fleet commanded by Von Spee which, months later, met Cradock at Coronel and Sturdee at the Falkland Islands. I remember some of the story because I was called from Sydney to Melbourne by the Australian Government to help in an advisory way with an interesting application of wireless. At this moment the German fleet was cruising to the north of Australia and was in nightly touch with Yap. As soon as this was observed each of the small shore stations along the Australian coast was instructed to listen for the signals of the German fleet, to record daily the strength with which the signals were received, and to report daily to Melbourne. From these reports, by a process resembling triangulation, an estimate was made in Melbourne of the changes of position of the fleet. Meanwhile a British naval force had set forth with the object of destroying the wireless station at Yap. This was duly accomplished, and for days afterwards the Germans, unaware of the disaster, continued to call the dead station, in vain. These continued calls, by helping us to keep track of the fleet, eased the anxiety of those who knew that the New Zealand expedition was then well on its way to capture Samoa. Thus ends the story of Yap; that of the other German colonial stations was similar.

During the war our wireless energies were deflected from the building of great stations to producing relatively small outfits for fighting purposes. War telegrams were handled sufficiently well by the cables and the wireless stations of the Admiralty. And the war closed without any progress in imperial wireless. Meanwhile the French Government had erected powerful stations at Nantes, Lyons and Paris, and smaller stations in their African territories; the Italian Government had erected a large modern station at Rome; and the United States Government had completed half-a-dozen big stations, together with a magnificent one near Bordeaux which was afterwards purchased by the French Government. But the governments of the British Empire, at the close of the war, stood possessed of only one fairly large wireless station among them—that at Windhuk in German South-West Africa—captured by the forces of the Union of South Africa under General Smuts. Thus at the end of 1918 the Empire was far behind most other great Powers as regards government-owned stations, and, by the way, equally far behind as regards powerful commercial stations.

At this instant Lord Milner took up the case of imperial communications. Lord Milner appears to have been the only elder statesman of that day convinced of the value of widespread communications, and aware of our national backwardness. But he looked for much more than mere duplication of cable and land-line services. He envisaged the possibility of radiating daily from England and other great centres and opinions of imperial interest in such a form that they could be picked up, perhaps after re-transmission by outpost stations, anywhere.

Within a year of the conclusion of the war, Lord Milner appointed a committee, under the chairmanship of Sir Henry Norman, to investigate afresh the problem

of establishing a comprehensive wireless network. The committee found that the progress made in wireless during the war had completely changed the outlook. Plant was now available of at least double the effectiveness of the pre-war chain proposals. Accordingly the Norman committee recommended that wireless stations of about 250 kilowatt power, giving 120 kilowatts of continuous wave power to the antenna, should be erected in Egypt, East Africa, South Africa, India, Singapore, Hong Kong and Australia, with, possibly, similar stations in Canada for translatic and transpacific communication; and that a station of double the power of the others should be erected in England. Stations such as these, it was thought, would each be able to communicate at all hours with its nearest colleague even under the very bad conditions that afflict wireless reception in the tropics; and each would communicate with its most distant colleague during at least a few hours daily.

At this date there were no wireless stations in existence as powerful as those recommended, and, therefore, it was difficult to forecast what their performance would be. Moreover, the committee recommended that the stations should be equipped with thermionic valves. Now the largest valve station then known was of less than 20 kilwatts output, so the recommended English station was to be more than twelve times as powerful as its largest predecessor. The Report was, clearly, somewhat ahead of its time, but not, I think, too far ahead. For by the year 1925 ,only five years later, the Post Office station at Rugby has been built with thermionic valves yielding double the output recommended by the committee. The Rugby station has shown, besides, during the tests of the past few months, what the Norman committee's stations could have done. For example, the station recommended for South Africa would have communicated direct with England, Australia and India many hours each day, and the English station would have worked direct to the Antipodes more than twelve hours daily.

In 1923 the Government decided to erect in England without further delay a wireless station powerful enough to transmit almost continuously to all the Dominions and dependent Colonies, and to all ships of the navy and mercantile marine wherever they might be.

The time of waiting had not been lost. The commission had proceeded a long way with the plans of a large station, and the Post Office engineers had gained much experience by equipping with up-to-date plant the medium power stations at Leafield and Abu Zabal, remnants of the old Imperial scheme of 1913. As a consequence the erection of the Rugby station, the most powerful in the world, has gone forward with exemplary smoothness and withtout accident or failure of any kind. The station also contains the apparatus for the trans-Atlantic telephony experiment. The ultimate aim of this experiment is to connect any telephone subscriber in this country to any subscriber in the United States and Canada. By aid of the telephone circuits already constructed between England and the Continent it may be foun dpossible later to connect anyone in Western Europe to anyone in North America through Rugby. From this brief description you will understand that the Rugby station when in full swing will probably be able to transmit simultaneously three long-distance telegrams anw a telephone message.

When one realises that this multiple service station has cost only about half what the single service station near Bordeaux cost in 1919, one appreciates the great strides that wireless design has made during the past few years.(Rugby ,in fact, has cost about £400,000, much less than even the new stations at St. Assise near Paris and on Long Island near New York. Further, as the Leafield station began to earn, within a year of its opening ,more than covered its working expenses, so we may reasonably look forward to the Rugby station soon becoming a profit-earning concern.

It has always been obvious that the telegraphic traffic to and from the centre ofthe Empire will be greater than that to and from any of the Dominions; for the centre has to deal with all the Dominions, all the Dependencies and with distant shipping. The spokes all meet at the hub of the wheel. Therefore Britain must make much greater provision than even the largest Dominion, perhaps tenfold. Definite recommendations for the erection in England of stations additional to Rugby were made in the Report of the Imperial Wireless Telegraphy Committee, February, 1924, presided over by Sir Robert Donald. An opportunity of meeting the recommendations came in the summer of 1924, when the Government, finding the majority of the Dominions would probably agree to use the Marconi beam system,

made a contract with the company which will result in the establishment of duplex beam circuits between Canada and England, Australia and England, South Africa and England, and India and England. The arrangement promises a happy solution of many long-standing difficulties. These beam stations are now nearly completed. A transmitting station at Bodmin serves Canada and Sonth Africa, and a station at Grimsby serves both Australia and India. Corresponding stations are being erected in the four Dominions.

Before the end of this year the long-range wireless transmitting equipment of the Empire will include :—

(1) The multiple station at Rugby, comprising :—
  (a) Long wave plant of world-wide range.
  (b) Long wave plant of medium range
  (c) Short wave plant of world-wide range
  (d) An experimental telephony plant of range 4,000 miles.
(2) Medium power stations using long and short waves at Leafield, Oxfordshire, and at Abu Zabal, Egypt.
(3) Four beam circuits for duplex communication between England and the four largest Dominions.

Thus by the efforts of the engineers of the Post Office and the engineers of the Marconi Company the Empire will shortly possess the most up-to-date wireless equipment in the world.

So far I have dealt with things nearly completed, but now I must indicate briefly what has yet to be attempted and is within reach. In the first place there are important communities still unprovided with long distance wireless, for instance, New Zealand. This urgent necessity has been emphasised in the Report of the Donald committee. In the second place preparations onght to be made to utilise fully the news facilities. For instance, twice a day Rugby transmits a summary of news prepared by the Foreign Office, and, conceivably other news services may be arranged. If I were a settler in Uganda or the owner of a remote sheep ranch in Australia, I should install a simple receiving set and so keep in touch with the world. But this implies learning the morse code, not as hard as learning the typewriter, but still a difficulty ;and therefore in small communities where there is a local news sheet it would be more practical to organise a receiving service by paying an operator to listen regularly and decode the messages for the printer. In the Empire there are innumerable remote settlements to which the cabled news messages leak very slowly, and there are many which depend entirely for their news on the occasional visit of a ship All such outposts can now by the aid of a simple receiving set be made to feel that they are within five minutes of Fleet Street. Moreover, if these stations were registered messages could be specially addressed to them from Rugby just as telegrams are addressed to-day to ships on distant oceans.

Another method of distributing the morse messages from home when received, say, in New Zealand, is to announce them, after decoding, through the local broadcasting stations. In each of the Dominions such statons aer growing in numbers, and by their aid messages could be distributed pormptly to millions of listeners-in. Of course, it may some day be possible, after further invention and development, for speech and music from England or other centre to be put on to every local broadcasting station in the Empire; but I refrain from such prophecy and am now speaking of what can be acomplished to-day by mere organisation of existing facilities.

But this does not exhaust the possibilities now arising. During the past two or three years wireless amateurs have succeeded in transmitting signals and even speech across vast distances with tiny apparatus. I have some lantern slieds showing the apparatus used by Mr. Marcuse and Mr. Simmonds in talking with people similarly equipped on the Amazon and in New Zealand and elsewhere. The plant is so small that it could be installed in a drawing room. If only we could rely upon plant of this size getting through for days instead of hours then there would be no need for high-power stations. Even so it is easy to imagine how such glimpses of inter-communication might be made use of in the elaboration of Empire wireless.

NOTICES OF BOOKS.

Flame and Combustion Gases. By William A. Bone, D.Sc., F.R.S., and D. T. A. Townend, Ph.D., D.I.C. London : Longmans, Green & Co., Ltd. (in the press).

The book will review comprehensively the results of modern research (particularly since 1880) and the present state of science regarding gaseous combustion and explosions, in five sections, namely :—(i) Histori-

cal, reviewing the principal discoveries from the time of Boyle to the end of the Bunsen Era (1660-1880); (ii) Ignition Phenomena, Flame Propagation through Explosive Mixtures, Detonation Flame Structure and Temperatures; (iii) Pressure Development during Gaseous Explosions in Closed Vessels; (iv) The Mechanism of Combustion; and (v) Catalytic or Surface Combustion. Photographs of flame movements and photo-spectrograms will be a special feature of the work.

Technologie Lučebnin Organických (Technology of Organic Compounds). By Dr. Cyrill Krauz, Professor at the Technical University of Prague. Part I. Aliphatic Compounds. Pp. 462. Prague : Nakladem Ceskoslovenské Spol. Chemické tiskem Unie (Czecho-Slovak Chemical Society). 1926.

Professor Krauz is one of a very energetic band of Czecho-Slovak scientists who are engaged upon building up a comprehensive and up-to-date literature for the increasing numbers of students which attend the Universities and technical institutes in his country. The present volume by him is one of a series of technological treatises which are now being published.

In the present part of his volume there are arranged all the compounds of the aliphatic series which are of any practical importance for technical or medicinal purposes with the exception of those bodies which form the subject of some special branch of the chemical industries as, for instance, petroleum, tar, dyestuffs, sugar, alcohol, aldehyde, acetone, leather, etc.

The author describes all the known methods of manufacture and the application and uses of the many hydrocarbons, their halogen derivatives, the alcohols, aldehydes, ketones, acids and their derivatives and compounds.

The cyanogen compounds and the carbonic acid derivatives and dependent industries are described separately and *in extenso*.

It is noteworthy that there have been few, if any, works of this kind in which the manufacturing processes of organic compounds and the technical details are collected and given in such a textbook.

The systematic treatment which follows the usually accepted divisions into homologous series, is prefaced by a brief indication of the principal compounds used in pharmacology and therapeutics. These lists occupy eight pages and the practice is one which could be followed by English authors.

In the section of nitrogen fixation a number of photographs are included showing the plants used at Falknov in Bohemia, for making calcium carbide, cyanide and cyanamide. This section appears to be exceptionally well done and an English account of it would not be without interest to many unacquainted with Czecho-Slovak industrial enterprise.

Succeeeding volumes (II. and III.) will contain descriptions of the alicyclic and heterocyclic series of compounds.

J. G. F. D.

FORTHCOMING EVENTS.

UNIVERSITY OF LONDON (UNIVERSITY COLLEGE).

(Gower Street, London, W.C.1.)

Friday, January 21, at 6.30 p.m.—"The Literary and Historical Study of the Bible : The New Testament—Epistles." A public introductory Lecture to a Course of University Extension Lectures by Miss M. S. West, B.D., B.A. Chairman : The Ven. R. H. Charles, D.D., Archdeacon of Westminster.

Monday, January 24, at 4.15 p.m.—"Les Cours d'Amour." A public Lecture in French by Professor L. M. Brandin.

Monday, January 24, at 6 p.m.—"Science and Poetry." A public introductory Lecture by Dr. H. D. Jennings White.

Thursday, January 27, at 5.15 p.m.—"Legislative Tendencies in the English-Speaking World." First of a Course of seven public Lectures by Professor J. E. G. de Montmorency. January 27, February 3, 10, 17, 24, March 3 and 10.

Monday, January 31, at 2 p.m.—"Ancient Classical Drama and Pastoral Poetry." First of a Course of six public Lectures by Professor H. E. Butler. January 31, February 7, 14, 21, 28 and March 7.

THE ROYAL INSTITUTION.

Tuesday, January 25, at 5.15 p.m.—"Smokes as Aerial Disperse Systems." By Professor R. Whytlaw-Gray.

Thursday, January 27, at 5.15 p.m.—"Early Pointed Architecture in Spain." By Mr. J. R. H. Weaver.

Friday, January 28, at 9 p.m.—"The Physique of Women Employed in Industry." By Professor E. P. Cathcart.

Saturday, January 29, at 3 p.m.—"English Mediaeval Wall-Painting." By Professor E. W. Tristram.

ROYAL SOCIETY OF ARTS.

Wednesday, January 26, at 8 p.m.—(Ordinary Meeting)—F. W. Spencer, Birmingham Small Arms Co., Ltd. : " British and American Practice in Hot and Cold Working of Metals."

Monday, January 31, at 8 p.m.—(Cantor Lecture.)—L. C. Martin, D.Sc., A.R.C.S., Assistant Professor, Technical Optics Department, Imperial College of Science and Technology : " Recent Progress in Optics." (Lecture III.)

Wednesday, February 2, at 8 p.m.—Norman Evers, B.Sc., F.I.C. : " Chemistry and the Supply of Drugs."

THE FARADAY SOCIETY.

Wednesday, January 26, 1927, at 8 p.m. —Ordinary meeting, in the Rooms of the Chemical Society, Burlington House, London, W.1. Papers to be read and discussed :—

" The Behaviour of the Quinhydrone Electrode in Solutions of Neutral Copper Sulphate." By J. B. O'Sullivan.

" The Actinic Absorption of Chlorine Gas with Respect to the Hydrogen Chlorine Reaction." By W. Taylor.

" The Residual Effect in the Actinic Absorption of Chlorine." By W. Taylor and A. Elliott.

" Vapour Pressure and Heat of Dilution of Aqueous Solutions. Part II." By W. R. Harrison and E. P. Perman.

" The Electrostatic Capacity of Aluminum and Tantalum Anode Films." By N. A. de Bruyne and R. W. W. Sanderson.

" On the Velocity of Chemical Reaction in the Silent Electric Discharge," By G. A. Elliott, S. S. Joshi and R. W. Lunt.

" The Activation of Hydrogen in the Electric Discharge." By G. A. Elliott.

" The Soret Effect." By C. C. Tanner.

" An Improved Method of Measuring Vapour Pressure by Air Bubbling." By I. I. Downes and E. P. Perman.

BRITISH DRUG HOUSES.

Catalogue of Fine Chemical Products.

We have been favoured with a copy of the 108-page Catalogue issued by the above well-known Company. It includes organic and inorganic chemicals, analytical reagents, indicators, standard stains, etc., and is arranged in alphabetical order. Any reader interested may obtain a copy by writing to The British Drug Houses, Ltd., Graham Street, City Road, London, E.C.1.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

33,071.—Chemische Fabrik Pott & Co.—Condensation products of aromatic sulphonic acids. December 31st.

32,887.—Hereward, H. W.—Dyes, etc. December 29th.

32,956.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of dyestuffs. December 30th.

32,851.—Kritchevsky, W.—Chemicals for colouring fabrics. December 29th.

32,887.—Scottish Dyes, Ltd.—Dyes. December 29th.

Specifications Published.

263,370.—I. G. Farbenindustrie Akt.-Ges. —Process for the manufacture of 1 : 4 - Diarylamino - 5 : 8 - dioxy-anthraquinones.

Abstract Published.

261,133.—Organo arsenic compounds.—Ransford, A. J., 24, Southampton Buildings, London, W.C.2.

2 : 1-*Benzoxazolone-5-arsinic acids* are prepared by reducing 5-nitrobenzoxazolone or a derivative thereof and diazotizing the resulting amono compound in the presence of an arsenite. The products possess therapeutic properties. Examples are given of the production of 2 : 1-benzoxazolone-5-arsinic acid from 5-nitrobenzoxazolone, 3-methyl-2 : 1-benzoxazolone-5-arsinic acid from 3-methyl-5-nitrobenzoxazolone, and 3-chlor-2 : 1-benzoxazolone-5-arsinic acid from 3-chlor-5-nitrobenzoxazolone. Specification 240,969 is referred to.

5-*Nitrobenzoxazolone and its derivatives* are obtained by the action of phosgene on 1-hydroxy-2-amino-4-nitrobenzene and its derivatives. The preparation of 5-nitrobenzoxazolone from 4-nitro-2-aminophenol, of 3-methyl-5-nitrobenzoxazolone from 5-nitro-3-amino-2-hydroxy-1-methylbenzene, and of 4-chlor-5-nitrobenzoxazolone from 5-nitro-3-amino-2-hydroxy-1-chlorbenzene, is described.

Monoazo dyes. The 5-aminobenzoxazolones which result from the reduction of the 5-nitrobenzoxazolones may be diazotized and coupled with resorcinol or R-salt. Both 5-amino- and 3-methyl-5-aminobenzoxazolones give yellow-red solutions with resorcinol and red-violet solutions with R-salt, whilst 3-chlor-5-aminobenzoxazolone gives an orange solution with resorcinol and a bluish-red solution with R-salt.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ALBERTOL.

472,311.—Chemical substances used in manufactures; and laquers and varnishes in class 1.—Chemische Fabriken Dr. Kurt Beschrankter Haftung, Landgrabenweg 14, Amoneburg, near Biebrich on the Rhine, Germany. January 5th.

DIMOL.

475,397.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Dimol Laboratories, Limited, 40, Ludgate Hill, London, E.C.4. January 5th.

TASHALINE.

471,353.—Chemical substances prepared for use in medicine and pharmacy, but not including Petroleum Jelly and preparations thereof, and not including any goods of a like kind to these excluded goods.—Laboratium "Tasch" Aktiengesellschaft, Gartenstrasse 1, Allschwill, near Basle, Switzerland. January 5th.

PIXIE.

475,473.—Chemical substances prepared for use in medicine and pharmacy.—George Barras Smith, 73, Dunlop Street ,Glasgow. January 5th.

SUBSCRIPTION TO "THE CHEMICAL NEWS."

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INDEX TO VOL. 133.

The Index to Vol. 133 (July to December 1926) is published this week and included with the current issue, dated 28th January, 1927.

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NOTE ON THE WAVE-LENGTH OF THE K-BETA-ONE LINE OF RUTHENIUM.

By F. H. LORING.

In the *Chemical News* of December 3, 1926, p. 356. reference was made by the present writer to the probable wave-length (in Angström units) of the $K\beta_1$ line of Ru being near to 0.572.

In Siegbahn's "Spectroscopy of X-Rays" (1925), the very approximate value is given in the Appendix as 0.574. On page 104 of the same book, Auger and Dauvillier's determination of the wave-lengths of the Ru lines for the K series are cited as follows :—

$$\alpha_2 = 0.6454, \alpha_1 = 0.6410$$
$$\beta_1 = 0.5705, \beta_2 = 0.5593.$$

On page 105, of the same book, the precision values of Ru are given as follows :—

$$\alpha_2 = 0.64588, \alpha_1 = 0.64154,$$
$$\beta_1 = \text{———}, \beta_2 = \text{———}.$$

It will be seen that the truer values in the case of the α_2 and α_1 wave-lengths are about 0.0005 A units higher than those of Auger and Dauvillier. This suggests that the β_1 value of Auger and Dauvillier is about 0.0005 low. Adding this difference gives the wave-length 0.5710 for the $K\beta_1$ line. The experimental value given by the present writer in the *Chemical News* (*loc. cit.*) is 0.5724. Averaging these two values gives 0.5717.

On calculating the wave-length from the $(\nu/R)^{\frac{1}{2}}$ values of the K series, given on page 108 of Siegbahn's book, and adjusting by means of an undulatory difference-curve, gives the value 0.57133. In making this calculation the $K\beta_1$ line for element of atomic number 43 has to be evaluated, and this comes out at 0.59093.

No absolute reliance can be attached to any one of these values, but an average may be taken thus :—(0.5710 + 0.5724 + 0.57133)/3 = 0.57158.

It is therefore assumed that the wave-length 0.5716 A is the best value to take in the circumstances. It will be seen that the measured value, 0.5724, cannot be, however compared, very appreciably in error, and that the " best " value is very close to the more approximate one 0.572, as previously cited (see above).

It might be mentioned in this connection that the Rydberg constant, R, used by Siegbahn is 109737, which is in agreement with the value recently considered best by Birge (*Phys. Review*, Oct., 1926, p. 848), *viz.* : 109737.3 plus or minus 0.3. This is, of course, R for an infinitely massive nucleus.

AN APPLICATION OF COLLOID CHEMISTRY TO LUBRICATION.

By RAYMOND SZYMANOWITZ.

ABSTRACT.

The high lubricating efficiency of colloidal graphite in oil and water solution, introduced to commerce by Acheson as "Oildag," and "Aquadag," is treated from the standpoint of adsorption and interfacial tension.

An outline of crystal analysis by X-ray methods serves to familiarise one with the structure of matter and the existence of secondary valence. The latter force acting on surface areas creates a stray field which explains surface energy.

The colloidal graphite particles, found by Freundlich to be less than 500 millimicrons in many cases, when subjected to the stray forces of the friction surfaces, are ultimately adsorbed to form a "graphoid" surface. The work of Hardy, Wells, Southecombe, and others, is cited to emphasise the importance of adsorption in lubrication.

The low interfacial tension existing between graphoid surfaces and oil enable the latter to better "wet" the friction surfaces, thus contributing to the reduction of the frequency of oil film ruptures. The ability of the graphoid surfaces to carry loads during possible ruptures of the oil film provides double lubrication.

References made to the studies of Mabery and Saytzeff on colloidal graphite lubrication show a marked reduction in the coefficient of friction and oil consumption.

—*Journal of Chemical Education.*

UNVERIFIED ELEMENTS.

In the January number of *Science Progress* there is an article by J. G. F. Druce entitled "Elements whose existence has been announced but which are not recognised." Many claims to the discovery of new elements which were made during the last century remain unconfirmed and considerable doubt has been cast upon their existence, since no place is available for them in the Periodic Classification, although this does not apply to the rare gases of the atmosphere which were unknown at the time of Mendeléef's advancement of that Law.

The claims to the discoveries of new elements are grouped as follows :— (1) Elements said to have been identified by spectrum analysis, (2) Elements believed to have been found in Rare Earths, (3) Elements reported in Zircon Minerals, (4) Elements reported in Platinum Minerals, and (5) Announcements of unspecified new earths and new elements.

A special interest attaches to the investigations on zircon minerals since Coster and Hevesy's isolation of hafnium in 1922. At least four claims to the presence of another element in zirconium compounds have been made apart from the work of Coster and Hevesy which has put the matter beyond doubt. These previous reports indicate that all the alleged claims to the discovery of new elements are not due to errors or bad work. Thus the Jargonium of Sorby (*Chemical News*, 1869, XIX., 205, 7), and Church (*ibid.*, XIX., 152), might well have been impure hafnium.

The bibliography at the end of the article contains 81 references, the *Chemical News* being cited in no less than 21 of these.

COMPRESSIVE AND TRANSVERSE STRENGTH OF HOLLOW-TILE WALLS.

By A. H. STANG, D. E. PARSONS, AND H. D. FOSTER.

(*U.S.A. Bureau of Standards.*)

Strength tests of 70 hollow-tile walls constructed with ordinary workmanship and built under average indoor conditions were made. The walls tested were all 6 feet long and 9 feet high and either 8 or 12 inches thick. Fourteen different lots of tile and four different mortar mixtures were used in their construction. Twenty-seven of the walls were subjected to a transverse test before being tested in compression under central loading. Fifty-three of the walls were tested in compression under central loading and 17 under eccentric loading.

The mortar and workmanship seemed to be the most important factors affecting the strength of the end construction walls. Those with cement-lime mortar (1C :1l/4L :4S) were about 5.1 times the strength of those with lime mortar (1L/45 :3S). The mortar had relatively less effect upon the strength of the side construction walls. Those with cement-lime mortar had 2.4 times the strength of those with lime mortar. There seemed to be no constant ratio between the strength of the walls and the strength of the tiles, but, in general, using the same mortar, this ratio decreased with an increase in tile strength. With the

eccentrically loaded walls, the maximum loads supported were about 60 per cent. of the loads for similar walls centrally loaded.

The transverse strength of the walls was largely affected by differences in mortar and in the position of the tiles. In general, the stronger mortars gave higher transverse strengths, and the wall having the tiles laid on the side were stronger under side load than with the tiles on end.

NOTE ON THE MULTIPLICAND THEORY.

By Alexander Sakoschansky, B.Sc.

The observations on the multiplication of numbers, recorded in this short paper, form a part of the multiplicand theory. Previous to the actual multiplication, a process of exterpolation must be performed on the original number, which in this instance is :
232863579995701822983607993 . . . .

In the long division to obtain this number, the remainder up to 232 is 232865 (=8 × 26965). The first exterpolate is 28635. The 3 is left adjacent to 7999. 37999 is a group of recurring figures present in 1/112), and may be exterpolated; so that the complete exterpolate is a 10-figure number. The multiplicand is now 257 . . etc. (It is usual to write a letter to indicate the position of the exterpolate, thus 2M57 . . .).

In the product by a given number, the exterpolate associates must be found, in the single figure product, or in a group-figure product. In the present case, the multiplication is by 3546; while the product of 3 contains the figures 3257 in the region of the twentieth places; (024357). The complete product at the same position, is shown to be composed of fragments, which are in exact relationship with the exterpolate. Multiplying in this region only, the product is 29727, 53008675493l359237. The difference 53008 . . . - 29727 = 232811+540. 11454 = 4 × 28635. In this way the first seven figures are restored. The remaining *figures are also* acurately related, in this case by a logarithm. Log. 3190496203 is 5038582 (1 - 4961418) and log. 537999 is 7307815 and 77307815 + 7307815 = 50385965. In the more aucrate relationship (13 figs.) the number 1383 adds on to the logarithms and to the numbers.

ON THE IRREGULARITY OF THE $K\alpha$ DOUBLETS IN THE ELEMENTS OF LOWER ATOMIC NUMBERS.

By D. M. Bose.

(*Abstract from the "Physical Review."*)

In this paper attention is drawn to the recent measurements of the separation $\Delta\lambda$ of the $K\alpha$ doublets of the lighter elements from Al(13) to Ge(32) by Siegbahn and Ray and by Bäcklin. From these measurements it appears that the experimentally determined values of $\Delta\nu/R(Z - 3.5)^4$ deviate systematically from those calculated according to the relativity formula of Sommerfeld. This deviation is especially large in the case of the Fe group of elements. In order to acount for this deviation it is supposed that the experimentaly determined $\Delta\nu/R = \Delta\nu_{rel}/R + \Delta\nu_{mag}/R$. The first term on the right hand side is due to the relativity change in the mass of the radiating eletcron in the two orbits which produce the relativity doublet, and which can be calculated acording to Sommerfeld's formula. The second term is due to the difference in the magnetic energy of the excited atom corresponding to the two different k_2 values of the radiating electron. To calculate this term use has been made of the model which was proposed by Landé to explain the relativity doublet on a magnetic basis. According to the calculations it is shown that $\Delta\nu_{mag}/R(Z - 3.5)^3 = \alpha^2/14$ or $3\alpha^2/32$ according to the interpretation which is given to k_2. The first formula is obtained if k_2 determines the inclination of the orbit of the radiating eletcron, while the second formula is obtained if k_2 determines the shape of the electron orbit. The mean of the experimentally calculated values agrees better with the second formula.

The peculiar behaviour of the $K\alpha$ doublets belonging to the first transition group of elements is accounted for on the assumption that the inner magnetic fields in the atoms of these elements are large and therefore produce greater magnetic separation. It is further shown that the hypothesis, that the M_{33} sub-level is formed first in this group of elements, and the M_{32} sub-level, which was introduced in a previous paper to explain the paramganetic moments of these elements ,receive further support from the above mentioned data.

General Notes.

CHEMICAL COMBINE ALLOTMENT.

The Directors of Imperial Chemical Industries Limited, announce that Allotment Letters have been posted in respect of transfers "in order" received at the registered offices of Brunner Mond & Co., Ltd., Nobel Industries, Ltd., The United Alkali Co. Ltd., and British Dyestuffs Corporation, Ltd., up to 31st December.

Further batches of allotment letters will be posted at approximately weekly intervals.

The acceptances to date of the offer to exchange shares, has been entirely satisfactory, shareholders representing over 80 per cent. of the Ordinary Shares in each Company having agreed, and the acceptances from the other classes of shareholders being equally satisfactory.

In response to numerous requests from shareholders abroad and others who are prevented from completing the necessary formalities immediately, the Directors of Imperial Chemical Industries, Ltd., have decided to keep the offer open for a reasonable time beyond the 15th January named in the circulars to the shareholders.

THE BUILDING AND ORNAMENTAL STONE TRADE IN GREAT BRITAIN.

The Mines Branch of the Department of Mines at Ottawa has just issued, under Report No. 669, a report on the building and ornamental stone trade in Great Britain, prepared by Mr. W. A. Parks, following a visit to this country in 1925.

Copies of the report may be obtained by parties interested on application either to the Department of Mines at Ottawa, or to the Natural Resources and Industrial Information Branch, the Canadian Building, Trafalgar Square, London, S.W.1.

HOT SPRINGS IN WESTERN CANADA.

The Mines Branch of the Dominion Department of Mines has issued, under Report No. 669, particulars of an investigation by Dr. R. T. Elworthy, on the Radioactive and Chemical Properties of the Hot Springs of Western Canada, copies of which are obtainable by parties interested on application either to the Department of Mines at Ottawa, or to the Natural Resources and Industrial Information Branch, The Canadian Building, Trafalgar Square, London, S.W.1.

EXHIBITION OF PHYSICAL APPARATUS.

Under the auspices of the Physical Society and the Optical Society, the seventeenth Annual Exhibition of Electrical, Optical and other Physical Apparatus was held at the Imperial College of Science and Technology, South Kensington, on January 4-6.

A large number of firms exhibited new and recently desiged apparatus including microscopes, spectroscopes, refractometers, polarimeters, surveying instruments, coils, cameras, thermometers, pyrometers, and general electrical apparatus.

In the Research and Experimental Section there were a number of striking exhibits illustrating the recent advances in Physics. Thus the British Photographic Research Association showed an improved photo-electric photometer. Metropolitan Vickers exhibited short-path valves, a high temperature resistance furnace, and samples of zirconium and its alloys. The National Physical Laboratory arranged a number of experiments illustrating various phenomena and there were numerous other interesting exhibits.

During the exhibition discourses were delivered by Prof. E. N. da C. Andrade, Dr. C. V. Drysdale, and Mr. J. L. Baird.

THE F.B.I.'S TAXATION POLICY.

The Grand Council of the Federation of British Industries recently considered the Taxation Committee's Report, which was based upon opinions obtained at a series of meetings held throughout all the important industrial districts in England and Scotland.

This report was considered with regard to the policy to be pursued by the F.B.I. in approaching the Chancellor of the Exchequer before he finally decided upon his Budget.

The Federation recognised the difficult position in which the Chancellor of the Exchequer must inevitably be placed as the result of the protracted coal dispute, and that the losses consequent upon this would intensify his difficulties in balancing his Budget.

In spite of this, the Grand Council unanimously recommended that wherever the Chancellor might look for money, there should be no increases in direct taxation whatever, but that the loss to the revenue arising out of the coal stoppage should be regarded as a capital loss to be spread over a term of years. Simultaneously, the Federation most strongly reaffirmed their

constantly reiterated request for continued economy in the policy and administration of the Nation.

These recommendations will therefore form the main lines upon which the Federation will approach the Chancellor as soon as a meeting can be arranged.

The whole question of taxation has, of course, been considered by the F.B.I., in much greater detail, and a number of technical points will be brought to the notice of the Chancellor, the chief among which arise out of the change from the three years' average basis of assessment for income tax to the basis of the previous year only.

INSTITUTION OF MINING AND METALLURGY.

(225, City Road, London, E.C.1.)

A benevolent fund has been established. The usual difficulty of starting such a fund has been overcome by the generosity of an original member of the Institution of Mining and Metallurgy, the late Edward Riley, who bequeathed a legacy of £2,000 to the institution to be devoted to any purpose at the discretion of the council. The council decided that it should form the nucleus of a Benevolent fund. By the help of members of the institution and two balances at the disposition of the council, the fund started with about £3,000, of which £2,350 was invested on capital account. It is necessary that this capital sum should be largely increased to enable claims for assistance to be met from income.

In response to a letter addressed to the Boards of Mining Companies in November last, 36 companies have kindly sent subscriptions or donations; and several have promised to subscribe annually to the fund so long as they are paying dividends to their shareholders.

The Committee of Management hope members will contribute to the fund either by donations or by annual subscriptions. Cheques should be made payabel to "The Benevolent Fund of the Institution of Mining and Metallurgy," or, if more convenient to members, the amount may be added to remittances covering annual subscriptions to the institution, in which case contributions so sent would be duly transferred to the credit of the fund.

IMPERIAL CHEMICAL INDUSTRIES AND INDUSTRIAL PEACE.

An important exegesis has been issued showing the great part which the above company is playing in developing a great industry and also in fostering Industrial peace, so essential to the prosperity of the whole country, the following excerpts are suggestive.

While all other leading industries have suffered, some severely and others more slightly, from post-war industrial disputes, the heavy chemical industry has been singularly immune from any internal disputes for a long period of years. Brunner, Mond and Co., Ltd., indeed have had complete freedom from serious strikes during the whole of the 52 years of their history, while the Scottish factories of Nobel Industries Ltd., have been similarly favoured. Kynoch's factory of Nobel's has had no internal dispute since 1891, and the United Alkali Co., Ltd., and British Dyestuffs Corporation, Ltd., have equally satisfactory careers of industrial peace.

How has this gratifying result been obtained during a period when other leading industries have been torn and almost ruined by civil strife? The reason is not far to seek. It is due entirely to the consideration and fair treatment which those in control of the four companies have always accorded to each and everyone of their employees. Moreover, the spirit of justice and goodwill which has animated those in control has been faithfully observed and translated by the managers, and by those of the local staffs whose daily task brings them into constant and direct touch with the workpeople. The companies and their managers have always realised that a contented worker was their best asset, anl they have always aimed at doing the right thing by them and at giving all possible advantages to their workpeople. The will for peace was there in the first place, and it has been successfully carried into practice. Such is the reason for the splendid record of the four companies on the Labour side.

DEATH OF MR. JOHN WEBSTER.

The death is announced, at the age of forty-nine, of Mr. John Webster, who has held the office of Senior Analyst to the Home Office since 1919.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

JANUARY EXAMINATIONS, 1927.—PASS LIST.

Examination for the Associateship in General Chemistry.

Avent, Alfred George (Merchant Venturers' Tech. College, Bristol); Bunce, Edwin Herbert (Birkbeck College); Clulow, Frederick William, B.Sc. (Lond.) (Trained

under G. E. Johnson, Esq., F.I.C., at the Municipal Tech. College, Hull; and Bradford Technical College); Cocker, Leslie (Huddersfield Technical College); Hunecke, James Richard, B.Sc. (Lond.) (Trained under G. E. Johnson, Esq., F.I.C., at the Municipal Tech. College, Hull); Myer, Edward (Liverpool Central Tech. School); Taylor, Arthur Edgar (Birmingham Municipal Technical School).

KEY INDUSTRIES.

The following additional articles are chargeable with Key Industry Duty as from January 15th, 1926 :—

Optical glass and optical elements, whether finished or not.
Optical instruments.
Scientific glassware.
Laboratory porcelain.
Scientific instruments.
Synthetic organic chemicals (other than synthetic organic dyestuffs, colours and colouring matters imported for use as such, and organic intermediate products imported for their manufacture).
Analytical re-agents, all other fine chemicals (except sulphate of quinine of vegetable origin, and chemicals manufactured by fermentation processes.

NEW TECHNICAL COLLEGE IN SOUTH AFRICA.

H.M. Senior Trade Commissioner in South Africa reports that the Council of a South African technical college are proposing to erect new college buildings at an estimated cost of £50,000. No information is at the moment available as to the name of the architect appointed in connection with the scheme, but H.M. Senior Trade Commissioner suggests that interested United Kingdom firms who may be desirous of quoting for any of the fittings, furnishings, ets., likely to be required should forward copies of their catalogues and price lists to the college authorities.

Firms in a position to offer British materials, etc., can obtain the address of the College referred to on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1 (quoting Reference C.X. 2161).

OVERSEAS ORDERS FOR WATER STRAINER AND DE-AERATING PLANTS.

The British Engineers' Association report that a Lancashire firm have secured a number of important contracts from overseas for rotary water strainer and de-aerating plants. A de-aerating plant to deal with 326,700 lbs. of feed water per hour has been ordered by the Imperial Continental Gas Association, Ltd., for erection at Droogenbosch, Belgium, and five plants each capable of dealing with 56,000 lbs. of water per hour have been ordered by the Anglo-persian Oil Company, Ltd., for their power stations in Persia. A water strainer plant to deal with 540,000 gallons per hour has also just been ordered by the Capetown Corporation. Among other countries, Russia has recently placed contracts for this type of plant.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read on Thursday, January 20, 1927 :—

On the Form and Energy of Crystalline Sodium Nitrate. By J. TOPPING AND S. CHAPMAN, F.R.S.

Te total potential energy of crystalline $NaNO_3$ has been found for a series of configurations of the ions of the crystal by the addition of the potential energy due to the intrinsic repulsive forces between the various ions, to the electrostatic potential energy which was calculated in a previous paper. The stable *configuration* of the crystal corresponding to a minimum value of this energy has been found for various values of the distance b between the N and O ions of an NO_3 group.

This series of stable configurations does not include the actual measured configuration, but it is shown that certain changes in the repulsive-force data given by Lennard-Jones and Dent, not much outside the margin of possible error which they ascribe to their data, suffice to make the series of possible stable configurations pass through the observed configuration.

The value of b suggested by these considerations is about 0.96 A, which is somewhat larger than the value of 0.72 A given in the former paper, and reasons for the discrepancy are indicated.

Quasi-Unimolecular Reactions.—The Decomposition of Diethyl Ether in the Gaseous State. By C. N. HINSHELWOOD. Communicated by H. Hartley, F.R.S.

The decomposition of gaseous diethyl ether is a reaction which obeys the unimole cular law at high pressures, but becomes

more nearly bimolecular at lower pressures. The velocity is represented by the equation

$$lnk = 26.47 - \frac{53,000}{RT}$$

A sufficient amount of hydrogen completely stops the falling off in the unimolecular velocity constant at low pressures; helium and nitrogen have little or no influence, while the reaction products in considerable excess have a slight retarding influence.

There are enough collisions to activate the molecules if the energy of activation is assumed to be distributed among about eight degrees of freedom.

These and other " quasi-unimolecular " reactions are most simply explained on Lindemann's theory.

A table is given showing the relation between the complexity of a molecule and the type of mechanism by which it decomposes. Simple molecules usually decompose bimolecularly; more complex ones in a quasi-unimolecular manner, as might be expected on theoretical grounds.

An X-Ray Investigation of Optically Anomalous Crystals of Racemic Potassium Chlorosulphoacetate. By W. G. Burgers. Communicated by Sir William Bragg, F.R.S.

In an investigation of crystals of racemic potassium chlorosulphoacetate

$$\begin{array}{l} CHCl.SO_3K \\ | \\ COOK \end{array} + 1\tfrac{1}{4}H_2O$$

by F. M. Jaeger, it was shown that these crystals exhibit an anomalous optical behaviour, and that variations occur in the angles between some of their faces. These facts led to the conclusion that the apparently orthorhombic crystals were in reality built up of perpendicularly crossed monoclinic lamellæ. The present investigation of the crystals by X-rays shows that the crystals are truly orthorhombic, and that the irregularities of their habit must be caused by a slight difference in orientation of successively crystallised layers. It is suggested that the optical anomalies are due to strains in the crystals. In this connection the fact is mentioned that the crystals investigated were of necessity grown from solutions containing KBr or KCl.

Te space-group of the crystals is Qh^{14}, the underlying lattice Γ'_0. The dimensions of the unit cell, which contains eight groups

$$\begin{array}{l} CHCl.SO_3K \\ | \\ COOK \end{array} + 1\tfrac{1}{2}H_2O \quad \text{are}$$

$a = 8.58$ A, $b = 8.60$ A, $c = 23.76$ A.

On Detonation of Gaseous Mixtures of Acetylene and of Pentane. By A. Egerton, F.R.S., and S. F. Gates.

On the Mutual Potential Energy of a Plane Network of Doublets. By J. Topping. Communicated by S. Chapman, F.R.S.

The mutual potential energy of a set of coplanar doublets with their axes all perpendicular to the plane has been found for two different arrangements of the doublets, *viz.*, at the net-points of (1) a square network, and (2) an equitriangular network. It is shown that if the number of doublets per unit area be the same in both cases, the energy per unit area is practically the same, only differing between the two cases by about 2 per cent. This result may be applied to a layer of polarised molecules on the surface of a fluid, so that a fairly definite estimate of the energy can be made for any probable mode of packing of the molecules.

Periodic Orbits of the Second Genus near the Straight-Line Equilibrium-Points in the Problem of Three Bodies. By D. Buchanan. Communicated by J .S. Plaskett, F.R.S.

Poincaré has shown the existence of orbits of two genera in the restricted problem of three bodies. All the orbits which have been exhibited by the various writers from Lagrange down to the present time belong to the First Genus. The paper of which this is an abstract exhibits orbits of the Second Genus.

The particular problem considered pertains to periodic oscillations in the vicinity of the Lagrangian straight-line equilibrium-points, when the two finite bodies move in circles and the third body is infinitesimal.

The First-Genus orbits near these equilibrium-points were first obtained by Darwin, and have been extensively considered by many prominent mathematicians since his time. The orbits, however, with which this paper is more particularly concerned, are those of Class A of Moulton's *Oscillating Satellite.* With respect to rotating axes, they have the shape of the figure 8, with the top and bottom of the 8 bent up from the page. They re-enter after one revolution.

The Second-Genus orbits here considered are in the neighbourhood of these figure-8 orbits, but re-enter only after many revolutions. The ratio of periods of orbits of the two genera is a function of distance between them at initial times.

The Deferred Approach to the Limit. By L. F. Richardson, F.R.S.

This is an investigation of the validity of

an arithmetical process, here called the "h^2-extrapolation," which has previously been used for solving differential and integral equations. We obtain by arithmetic, often easily, ϕ (x, h) the solution of the analogous problem in centred differences, made with step $h = \delta x$. If it is possible to expand thus

$$\phi (x, h) = f (x) + hf_1 (x) + h^2f_2(x) + h^3f_3 (x) + h_4f_4 (x) \ldots \text{ to inf.}$$

then f (x) the limit of ϕ (x, h) as $h \rightarrow 0$ is usually the desired solution of the problem in the infinitesimal calculus. Now if the function f_1 vanishes, and if further h can be made so small that $h^2f_2(x)$ is much larger than the sum to infinity of the higher terms of the series, then after solving the difference- problem for two unequal steps h_1, h_2, the unknown $f_2(x)$ can be eliminated and $f(x)$ found. This elimination is called the "h^2-extrapolation."

2. The method of investigating its validity is to obtain ϕ (x, h) as a fully explicit function of h. This is done by a study of the properties of the difference-operator δ and of Sheppard's averaging operator μ, combined with the Newton-Stirling and Newton-Bessel expansions in differences of ϕ. There is a general resemblance to corresponding operations in the infinitesimal calculus, but also a number of remarkable contrasts.

3. A particular arrangement of the arithmetic, which fits with the properties of μ and δ, is used throughout.

4. The investigation is restricted, except in §4.1, to functions $f(x)$, which can be expanded by Taylor's theorem.

5. No exceptions have been found to the rule that odd powers of h are absent from the expansion of ϕ (x, h).

6. General methods for finding how small h must be, in order to make the h^2-extrapolation valid, have been indicated, and have been applied in detail to some simple examples.

Some Theoretical Determinations of the Structure of Carbonate Crystals. Parts I. and II. By J. E. Lennard-Jones and B. M. Dent. Communicated by S. Chapman, F.R.S.

I.—This paper provides data for the calculation of the potential energy of any crystal of the calcite type for which the forces between the constituent ions are known. Two crystals, *viz.*, $MgCO_3$ and $CaCO_3$, are considered in detail, and for these theoretical determinations are made of the size and shape of the rhombohedral cells. In addition, the investigation determines an absolute value for the energy of these crystals, a quantity not yet determined by any other method. A value is also given for the parameter which determines the size of the CO_3 group.

II.—This paper provides a theoretical relation between the size of the rhombohedral cell of the carbonate crystals and the magnitude of the forces between the oxygen ions. From the information the forces between the oxygen ion (O^{--}) and the divalent ions of zinc, iron, manganese and cadmium are deduced.

THE CHEMICAL SOCIETY.

Papers read on Thursday, January 20.

The Glow of Arsenic. By H. J. Emeleus.

Arsenic undergoes a slow luminous oxidation at 260-300°. This glow occurs in pure oxygen only on reducing the pressure to a limiting value, which is analogous with the glow of phosphorus. The phenomenon was largely influenced by the dimensions of the apparatus, occurring most readily when conitions favoured diffusion and consequent removal of the oxidation product. In a gas stream, arsenic glows at approximately the same temperature in air as in oxygen. Pressure reduction appears to produce the glow by accelerating the diffusion of the oxide.

The Origin of the Spectrum of the Glow of Phosphorus. By H. J. Emeleus and R. H. Purcell.

Previous work on the origin of the ultraviolet band spectrum observed in the light from glowing phosphorus is ambiguous. The spectrum of the phosphoresence of phosphorus pentoxide at the ordinary temperature and when cooled with liquid air was photographed, using a condensed spark for excitation. It gave a continuous spectrum in the visible region, with a maximum intensity in the green. None of the bands characteristic of the glow of phosphorus were observed. Photographs of the discharge through phosphorus pentoxide in a silica tube with external electrodes gave a complex band spectrum, which included all the known bands in the spectrum of the glow of phosphorus. A re-examination of the latter phenomenon has shown further bands common to these two spectra. It is concluded that the spectrum has its origin in the molecule of an oxide, and not in that of a hydride.

Ring-Chain Tautomerism. Part XVI. The Effect of Two Adjacent Gem-*Dimethyl Groups on the Ease of Formation of the* Cyclo*pentane Ring*. By I. VOGEL.

A study of the tautomerism of αδ-diacetyl-ββγγ-tetramethylbutane (I) has shown that the compound reacts exclusive in the form of the ring isomeride (II as would be expected from the modified strain theory of Thorpe and Ingold. In addition to purely chemical evidence, confirmation of the structure (II) has been obtained from measurements of the parachor.

$CMe_2.CH_2COMe$	$CMe_2.CH_2$
|	| $>CMe.OH$
$CMe_2.CH_2COMe$	$CMe_2.CH.COMe$
I	II

ROYAL INSTITUTION OF GREAT BRITAIN.

The following paper was read on Friday, January 29, 1926, Sidney G. Brown, F.R.S., M.I.E.E., in the chair—

Films. By SIR WILLIAM B. HARDY, F.R.S, Fellow and Tutor of Gonville and Caius College, Cambridge.

The title of this discourse is perhaps misleading. It has, I find, suggested to my friends a popular form of entertainment. Let me hasten to set this right. I shall have nothing to say about the cinema! My subject is something quite different—namely, those thin films of matter, familiar to all in the form of soap bubles or lubricating films of oil.

The subject is of great scientific interest. You all of you know of the three states in which matter can exist—solid, fluid and gas or vapour. These films are no less than a fourth state, because, choose what physical constant we may, it will have a different value for any particular kind of matter in this state to what it has in any of those other states which are more easily apprehended by the senses.

Life itself depends upon this fourth state of matter. There is a film spread over the surface of each living cell which seems to control the passage of substances into or out of the cell. This film is actively maintained by the expenditure of energy on the part of the cell. The new technique of microdissection, by which living cells so small as to be almost or quite invisible can be dissected, has increased our knowledge of this sufrace film. If it be punctured at one place, the living matter in the neighbourhood of the puncture becomes curdled in appearance and dies, but the membrane grows in at the back of this dead substance cutting it off from the rest of the cell. This is the fundamental surgery of life.

I cannot hope to do more in one hour than deal in haphazard fashion with this vast subject. I propose to begin with an experiment which, in spite of its simplicity, shows how ubiquitous films are, and how our mostelement ary impressions of the external world depend upon them.

Take, for example, smoothness. It is not a property of solid matter in mass, but of this fourth state of matter. A tea-cup has the delicate velvety feel of a polished surfact; but neither porcelain nor ware is realy smooth in that sense. Their surface, like that of all other naturally occurring surfaces, is covered by a film of greasy matter, which can come from the atmosphere or from the "clean" cloth with which the object has been dried. If that film be removed the surface feels harsh and rough, because, to use the engineer's phrase, one's finger-tips ,if they are freshly washed, seize to it.

It is not possible here and now to remove the film. The necessary procedure would take too long, and in any case the film would quickly re-form in this otmosphere. I can, however, destroy its effectiveness by taking advantage of a curious property of water. That substance is not only not a lubricant for vitreous surfaces, but it is also an anti-lubricant in that it destroys the effect of the natural lubricating film. All I have to do therefore, is thoroughly to wet the surfaces of the tea-cup and saucer, and the tea-cup ceases to slide in the saucer.

A tea-cup suggests a storm, and that suggests the curious power which oil has of smoothing the sea. The oil spreads over the surface of the water until the layer is only about the five-millionth of a millimetre in thickness. A figure of that kind is apt to mean little; I will therefore try to give you an impression of the minute quantity of oil needed in another way. In 1919 an oil ship was wrecked inside the Lizard. The oil-tanks were burst open and the oil rapidly escaped. There has been no sensible quantity of oil in the wreck for the last six years, yet sufficient still escapes to the surface of the sea to produce an obvious "smooth" for a mile or more to leeward. The effect of a film of oil of quite invisible thickness upon the sea is very real. A vessel labouring in a sea-way or running before a gale can, and does, find some measure of safety by streaming bags filled with oil to windward, and

Pliny records how the oyster-fishers used oil to calm the surface of the sea so that they were more easily able to work.

It is obvious that the presence of this oil film cannot seriously modify the energy of great seas, say, a quarter of a mile from crest to crest; but when seas enter a "smooth" they change their character with dramatic suddenness. They lose their viciousness, and the moment they are in the "smooth" take the character of those relatively harmless undulations which do not break on to a vessel, but merely make her roll and pitch. The question how the oil film, so tenuous as to be of invisible thickness, curbs the seas is an interesting one, and the attempt to answer it will inevitably introduce us to the chief properties of films on water.

In the late nineties a most ingenious method of demonstrating the existence of films on water, and of controlling them for experimental purposes, was devised by a German lady, Fräulein Pockels. I think I may say without exaggeration that the immense advances in the knowledge of the structure and properties of this fourth state of matter which have been made during this century are based upon the simple experimental principles introduced by Miss Pockels. I propose now to make use of her method. Here is an oblong trough of metal filled with water. On the surface of the water, quite invisible to you because it is even thinner than the invisible dead black portion of a soap film, there is a layer of greasy contamination. If I lay upon the trough a strip of glass or metal so that it touches and it wetted by the water, and move it along, I can compress the superficial film in front and expand it behind. Both processes are easily rendered visible by scattering lycopodium dust on the surface.

The capacity which these films have of expansion is easily shown by sweeping the natural film to one end, thus leaving a tolerably clean surface of water behind. Some lycopodium dust is now placed at one end and the surface touched with a platinum wire, the extreme tip of which has just been dipped into an oil. The dust particles are swept swiftly away in front of the advancing film of oil, although the film itself is absolutely invisible.

The film tends to spread, but the surface of the water in virtue of its surface tension tends to contract. It is this same surface tension which rounds up drops of fluid to spheres, or as near an approach to the spherical shape as other forces which may be operating, such as gravity, permit. There are therefore opposing influences : the tendency of the water to contract, opposed by th tendency of the film to xpand, with the result that composite surfaces of oil and water have a surface tension less than that of pure water. Composite fluid surfaces have also an enhanced mechanical stability. When a ring of wire a few centimetres in diameter is withdrawn from clean water no film is formed across it, but when the surface of the water is coated with oil it acquires the property of forming free films, which may have an endurance comparable even with that of a soap bubble.

Do these properties of composite surfaces, namely, the lowered surface tension and the increased mechanical stability, explain the calming of the sea In my opinion, the answer is "No," but current doctrine would perhaps say "Yes." It has been pointed out that the special capacity of composite surface to resist extension and their mechanical stability, which is only another special aspect of the same thing, tends to prevent the inevitable expansion of the surface which occurs when a wave is formed. This has been held to be a sufficient explanation. I do not think it is, and for two reasons. The first is that the surface of the sea always is contaminated by something which lowers its surface tension and gives to it a remarkable measure of mechanical stability. One of the most striking aspects of a heavy gale is the "windrows," which are due to the foam formed when a sea breaks being blown by the wind in long lines over the surface. Foam after all is no more than a collection of bubbles; obviously therefore, these naturally formed bubbles have great stability.

The surface of the sea is already covered by a film of matter the nature of which must remain uncertain. Somptimes it is composed of substances, like saponin of vegetable origin, derived from the masses of seaweed flung upon the coast. Foam of this kind is remarkably stable. I have seen it on the day following an on-shore gale knee-deep in the hollows above Flamborough Head. The bruising and shattering of seaweed is however a coastal happening, and "windrows" are deep-sea phenomena.

The true explanation was, I think, furnished by Benjamin Franklin, in 1773. His discussion is worth reading. It has the spacious dignity and charm which the hurry and specialisation of to-day have of neces-

sity banished from scientific papers. He tells how he was at sea in 1757 with a convoy of 96 sail, the wind being very fresh, and how he noticed a " smooth " in the wake of two of the vessels. He enquired the cause of one of the officers and was told with some degree of contempt, it being a thing which every fool should know, that the cook had just thrown greasy water over the side. In those days tallow was used to coat the bottoms of vessels to keep them clear of growth, and Franklin also notes the " smoothness " in the wake of vessels which had been freshly tallowed.

Franklin's explanation is based entirely upon friction. The oil makes the sea so very smooth that the wind cannot " catch upon it." I confess Franklin's explanation did not appeal to me at first, but I believe he is right. The comparative safety of a " smooth " is due not to the fact that the seas in it are sensibly smaller than those outside of it, but to the fact that they have been deprived of their viciousness. Now the viciousness of a sea, the degree of danger it carries to the mariner, is measured by its instability. It is when the head of the sea topples over and becomes a mass of water moving with a high velocity that it is dangerous. Within the limits of a "smooth" produced by oil the seas cease to break, or to " crack," as Cornish fishermen say. The wind not only drives a sea forward by its horizontal pressure, but also draws the crest upwards by friction against the surface of the wave.

If the friction between the air and the water be greatly reduced, the wind fails to life the crest of a wave to the point at which it is blown bodily over by the horizontal pressure. The wave then sinks down to a relatively harmless " swell."

The " catch " of the wind upon the waves is not however confined simply to a direct frictional pull, and here it is that the surface tension phenomena perhaps come in. It is easy to convince oneself that an oil film prevents the formation of ripples—that is, of the very smallest kind of wave. When there is no oil film a great wave carries countless ripples and wavelets each of which gives the wind a direct thrust on the surface. It is to the suppression of ripples and wavelets that the characteristic smooth appearance is due, and when they cease to be formed the chief " catch " of the wind upon the sea is lost.

SOUTH AFRICAN CHEMICAL INSTITUTE.

In his Presidential Address at the last annual meeting, the President, Mr. H. H. Dodds, M.Sc., A.I.C., said : " I have decided to speak to you on a branch of chemistry in which I have become interested during the past few years—that is, the manufacture of sugar. We have been told that the great gold-mining industry, which has done so much to develop South Africa in many different ways, is now at its zenith, if, indeed, it has not already begun to decline.

The group of industries which has already supplanted the mining industry in total value of production is the agricultural. Agriculture is perhaps the soundest and most fundamental industry for any country to possess, but those countries are the most prosperous to-day which have well-balanced agricultural, mining, and manufacturing industries.

If I may inflict a few statistics on you, which will be as few as is necessary to illustrate my remarks, the total value of the products of the mining industry of the Union for the year 1923, the most recent year for which official records are available, is £54,000,000, the total value of agricultural products at current market prices being £81,000,000, and of manufactured products produced within the Union for the same period being £74,000,000, the latter representing a value added to materials of £37,000,000.

The value of the sugar industry of the Union fluctuates largely from year to year, being dependent partly on output which is determined largely by whether the season has been more or less favourable, and also partly on world prices for sugar. The mean output of sugar during the past five years is 181,000 tons, that of the season recently closed being 240,000, and the mean value of the product during these five years is approximately £4,750,000. The annual consumption of sugar within the Union is now about 180,000 tons, and is steadily increasing. The total number of hands employed in the Natal sugar mills in 1925 was just over 9,000, of whom 4,000 were Indian, 4,200 natives, and 770 Europeans. There were harvested last year 2,600,000 tons of sugar-cane of a total value of about £2,160,000, of which £1,300,000 was received by the 600 cane planters, the balance representing cane owned by the millers. The planters are very largely European,

the cane produced by native and Indian planters forming an insignificant proportion.

The sugar idustry is one which is based on a branch of agriculture, the cultivation of cane or beet, but involves an elaborate manufacturing industry to prepare the field product into a form suitable for the consumer.

The industry of sugar and its by-products is of special interest to the chemist, whose services in it are required in many different phases. Its actual manufacture from the cane or beet leads him into many parts of the world, amid surroundings and novel experiences that are of fascination to those of a wandering and inquiring type of mind. Much of his environment will be sufficiently unfamiliar to be somewhat uncongenial, in the variable local conditions of climate and customs and standards of living to be met in the palm-studded islands of the West Indies, in turbulent Central America, or the Arcadian swamps of Louisiana. Nevertheless, to those of a certain temperament the life of a 'sugar tramp' appeals so much that they never leave it. Some of them may be found on the same tour year after year—for example, five months in Cuba, four months in the beet industry of California, and two months in Louisiana. Others who prefer to be more untrammelled than this follow no particular orbit, but may be heard of in Argentina, Fiji, Mexico, Egypt, Utah—wherever opportunity or fancy may lead them.

Yet the life is a hard one, with plenty of work and very little comfort or society at most sugar factories. Twelve-hour days, or even six hours on duty and six hours off of strenuous monotonous work seven days a week, is the rule, and the climate often far from healthy or bracing, and the moderate pay for all except the more responsible posts is no great recompense.

The harvesting and manufacturing season in the different sugar-producing countries does not in general last more than three to five months.

The system of chemical accounting in a sugar factory is of great interest, and in a well-conducted plant the records and flowsheets maintained are very elaborate.

The proportion and amount of sugar received into the factory in the cane is carefully calculated, and also the sugar actually recovered from it, together with the proportion of sugar lost, whether in the bagasse (extracted fibre of the cane), or the uncrystallised mother liquor known as molasses or treacle, or in the filter press mud, or in the other small sources of loss known collectively as undetermined losses. All are calculated at regular frequent intervals, together with the daily relative efficiency of the mills, the filter presses, the evaporating and the crystallising processes. These data require very numerous routine analyses of the most simplified character, and even more tedious stock-takings of such unpleasant materials to handle as final molasses, and above all, endless arithmetical calculations. Happy is the chemist whose factory owners have been considerate enough to provide a calculating machine. In addition to the mole-like industry and perseverance that all this requires, the sugar chemist must have linguistic powers of a high order, and be able to understand Spanish, French, American, and any other language or native dialect he may find in vogue. He must also school, bully and cajole his utterly unreliable native laboratory assistants into giving him reliable assistance, and teach them not to squander his precious and scanty supply of laboratory apparatus and reagents; and must in all his doing deal firmly, justly and tactfully with a host of individuals of uncertain dispositions and such as sugar boilers, engineers, accountants, managers, and owners and the like.

It will be seen, therefore, that many qualities are called for in the sugar chemist besides a knowledge of chemistry. And although a thorough knowledge of the theoretical foundations of his science is an advantage in many ways, there are many who have made good to whom the proof of the configuration of the glucose molecule, for example, has ever remained a sealed book.

A brief outline of the process of manufacture may be of interest to you. Although the bulk of the sugar made in factories is still what is known as raw sugar, or cargo sugar—that is, a coloured moist product containing about 97 per cent. of sucrose, which needs to be refined before it is a generally marketable product—the modern tendency is to produce within the factory a sugar suitable for direct consumption, and so dispense with a separate refinery; this is done either by producing with ordinary methods of purification a high grade of unrefined sugar which will suit many markets, or by operating a small vegetable carbon refinery as an adjunct to the factory, or by using a product indistinguishable in appearance and quality from that resulting from the bone char refinery.

Whatever the process may be, the juice is first expressed from the cane by passing

through a series of rollers. The first unit, or in some cases the first two units, are of a type known as crushers. These are two roller mills, the rollers having deeply indented surfaces of various patterns known as Krajewski, Fulton, and others, between which the cane is torn into small pieces to prepare it for the heavier milling to follow.

In some factories the action of the crusher in comminuting the mass is supplemented by some form of shredder of which the Searby is a well-known pattern. The milling machinery proper consists of a train of horizontal hydraulic rollers arranged in sets of three, the total number of these sets of rollers varying from two to six. The hydraulic pressure exerted is great, and may be as high as 500 tons or more on the seven-foot-long rollers used in the largest mills. The crushed case is conveyed through the series in the form of a uniform horizontal blanket of fibre. The extraction of the juice is aided by dilution, the more dilute juice from the later mills being sprayed on the cane leaving the first one or two mills, and the extraction of the later mills being increased with water. In this way the original sucrose content of the cane is reduced from an original value of 12 or 13 per cent. of the cane down to 4 per cent. or less in the residual fibre (now known as bagasse), and that without the use of more than about 30 per cent. of water to dilute the juice during extraction.

The bagasse passes on to the boiler furnaces, where it forms practically the sole source of fuel with an efficient steam-raising plant. In some countries, however, the bagasse is used instead as a source of coarse fibre for boarding and insulating material and the like ("Celotex"), or in some plantations in Hawaii as a paper mulch for the crops.

The daily grinding capacity of a large modern mill in Cuba may be up to 3,500 tons of cane per train of mills producing 400 tons of sugar. Many factories possess two trains of mills, known as tandems. One or two have the enormous capacity of 7,000 tons of cane daily in two or three tandems, or over 6,000 tons of sugar in one week. Central Delicias, in Cuba, in 1922 produced 170,000 tons of sugar in one season, which is over two-thirds of the largest total output recorded for the 25 factories operating in Natal. The factories in Natal are small by comparison, and the highest grinding capacity is about 1,500 tons of cane per day and about 24,000 tons of sugar per season.

A milling extraction of over 90 per cent. of the sugar in the cane may be considered satisfactory, although many Cuban factories are from 92 to 95 per cent. or over, and in Hawaii extractions of as high as 98 per cent. and over are not infrequently recorded. This figure, the extraction, or percentage of sucrose originally in the cane obtained in the juice, should be distinguished from the overall recovery, or proportion of sucrose originally in the cane recovered as commercial sugar. This naturally depends partly on the grade of sugar produced, but a recovery of over 80 per cent. as refined sugar may be considered good practice.

The expressed juice, which will have a sucrose content of about 13 per cent. with total solids 15 per cent., is a slightly acid and extremely turbid solution with a great variety of impurities, such as glucose and other reducing sugars, various salts, gums, waxes, and albuminoids. The process of sulphitation is used in the case of the manufacture of sugars intended for direct consumption without refining, or in Natal even in the manufacture of raw sugars, owing to the nature of the juice of the Uba variety of cane as met with in this country. For various reasons we are at present confined to the use of this one variety of sugar-cane.

The sulphur dioxide is generated simply by burning sulphur in a current of dry air, and the gas is then passed through a wooden tower down which the juice flows. The juice, which has originally an acidity of about 5.5 pH, is sulphited to an acidity of about 3.8 pH. This not only helps to decolourise the juice, but tends to flocculate and precipitate certain colloid impurities, and assists in the liming process which follows. The juice is then neutralised with milk of lime, the lime being added in some form of agitating tank until the mixture has attained the degree of neutralisation desired. This varies according to circumstances, but in general the point of true neutrality of pH 7.0 is found the optimum. A precipitate of calcium sulphite and the calcium salts of various organic acids is formed and a flocculation of the colloids takes place. The older method of determining the required addition of lime was to titrate a small portion with alkali, using phenolphthalein as indicator, but control of the neutralising process is now much more accurately and easily attained by the use of hydrogen-ion indicators of the desired range, such as bromthymol blue.

In order to increase and facilitate precipitation in the limed liquid, it is heated to not less than 90° C., usually by circulating

rapidly through long narrow tubes enclosed and heated by a steam jacket which may be either horizontal or vertical. The heated juice now containing a copious precipitate is allowed to subside in a series of open tanks known as defecators, whence the clear juice is decanted by means of suitably placed cocks.

The muddy liquors are passed through filter presses, usually of the ordinary plate and frame type, the filter press cake, which usually contains about 7 per cent. of sucrose, accounting for about 2 to 3 per cent. of the total sugar in the process, being usually discharged on to the fields as a useful fertilizer.

(*To be Concluded Next Week.*)

FORTHCOMING EVENTS.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

Gower Street, W.C.1.

Wednesday, February 2, at 5.30 p.m.—"Special Libraries." A public Lecture by Major W. E. Simnett, M.B.E., A.Inst.C.E.

Wednesday, February 2, at 5.30 p.m.—Newmarch Lectures: "Tests of the Trustworthiness of Public Statistics." First of a Course of six public Lectures by Professor A. L. Bowley, Sc.D., F.B.A. Also February 9, 16, 23, March 2 and 9. Chairman at the first lecture: Professor Karl Pearson, F.R.S.

Syllabus.—Methods of criticising statistics; consistency, alternative bases of estimates. Technical and popular definitions.

Rpplication to public statistics of population (totals and ages); occupation, unemployment; wages; income, capital; foreign trade; prices.

The lectures are open to the public without fee or ticket.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

Meeting at the Chemical Society's Rooms, Burlington House, Piccadilly, London, on Wednesday, February 2, at 8 p.m.

The following papers will be read:—

"Arsenic in Printing Inks," by T. Hedley Barry; "The Immersion Refractometer and its Value in the Analysis of Milk," by G. D. Elsdon, B.Sc., F.I.C., and J. R. Stubbs, M.Sc., F.I.C.; "Irish Moss Mucilage and a Method for its Determination," by Paul Haas, D.Sc., and Barbara Russell-Wells.

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, W.C.

Thursday, February 3, at 6 p.m.—Lieut.-Col. K. Edgcumbe, R.E. (T.A.), and F. E. J. Ockenden: "Some Recent Advances in Alternating Current Measuring Instruments."

Mersey and North Wales (Liverpool) Centre, at The University, Liverpool.—Wednesday, February 2, at 7 p.m.—Annual Dinner at the University Club.

ROYAL SOCIETY OF ARTS.

Wednesday, February 2, at 8 p.m.—(Ordinary Meeting). Norman Evers, B.Sc., F.I.C.: "Chemistry and the Supply of Drugs." Frederic William Gamble, F.C.S., Past Chairman of the British Pharmaceutical Conference, will preside.

ROYAL INSTITUTION.

21, Albemarle Street, Piccadilly, London.

Tuesdays, February 1, and 8, Wednesday, February 16, and Tuesday, February 22, at 5.15 p.m.: "Problems of Ainmal Growth and Development," by Julian B. Huxley, M.A.

Thursdays, February 3, 10, 17.—"Acoustical Problems Treated by Lord Rayleigh." 1, Æolian Tones; 2, Echoes; 3, Bells. By Sir William Bragg, K.B.E., D.Sc., F.R.S., M.R.I., Fullerian Prof. of Chemistry.

Saturdays, February 5, 12, 19 at 3 p.m.—Three lectures on 1, "Craftsmanship in Verse"; 2, "'Atmosphere' in Fiction"; 3, "The Supernatural in Fiction." By Walter de la Mare.

THE INSTITUTION OF MINING ENGINEERS.

Wednesday, February 2, at 11 a.m.—Annual General Meeting at the House of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. The Chair will be taken by the President (Dr. J. S. Haldane). The following papers will

be submitted for further discussion :—

"Miners' Dwelling-houses," by H. Eustace Mitton, M.Inst.C.E.

"The Haulage of Men Underground." Report of a Committee of the South Yorkshire Coal Trade Association.

"The Occurrence of Gas," by Robert Clive.

"Surveying Boreholes by the Briggs 'Clinophone' and 'Clinoscope,'" by A. D. Brydon.

"The Effect of Ventilation on the Cooling Power of the Air (Eleventh Report to the Committee on 'The Control of Atmospheric Conditions in Hot and Deep Mines')," by J. P. Rees, B.Sc., A.R.S.M.

"The Maximum Efficiency of Heat-Engines, and the Future of Coal and Steam as Motive Agents," by J. S. Haldane, M.D., F.R.S.

"The Thermal Efficiency of a Carnot Engine," by J. S. Haldane, M.D., F.R.S.

At 1 p.m. an adjournment will be made for luncheon, and the meeting will be resumed at 2.30 p.m., when the following papers will be read, or taken as read, and submitted for discussion :—

"A New Hygrometer for Mines," by W. Hancock, Ph.D., M.Sc., F.G.S., Mining Research Department, University of Birmingham.

"Local Air-conditioning Underground by Means of Refrigeration (Twelfth Report to the Committee on 'The Contral of Atmospheric Conditions in Hot and Deep Mines')," by W. Hancock, Ph.D., M.Sc., F.G.S., Mining Research Department, University of Birmingham.

7 for 7.30 p.m.—Dinner at the Whitehall Rooms, Hotel Metropole (Whitehall Place Entrance).

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

379.—Barnard, C. M.—Manufacture of dyestuffs, etc. January 6th.

441.—Chemische Fabrik auf Actien, vorm E. Schering.—Manufacture of new derivatives of 2-aminopyridine. January 6th.

174.—Seldon Co.—Catalytic oxidation of sulphur dioxide. January 4th.

214.—Hatfield, H. S.—Apparatus for chemical analysis. January 4th.

114.—I. G. Farbenindustrie Akt.-Ges. —Production of valuable products from coal tars, etc. January 3rd.

Specifications Published.

263,552.—Bentley, W. H., and Blyth & Co., Ltd., W.—Process for the manufacture of poly-nitro-amines.

263,579.—Soc. of Chemical Industry in Basle.—Dyeing acetyl-cellulose.

255,043.—Suida, Dr. H.—Process for the preparation of concentrated acetic acid from dilute aqueous or crude dilate pyroligneous acid.

255,047.—Suida, Dr. H.—Process for the preparation of concentrated acetic acid from dilute aqueous or crude dilate pyroligneous acid.

Abstract Published.

261,559.—Hydrocyanic acid.—I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

Hydrocyanic acid is produced by rapidly heating formamide or ammonium formate to high temperatures such as 400-900° C., with reduced pressure if desired. The reaction may be carried out in presence of a catalyst suitable for dehydration reactions such as alumina, bauxite, titanium oxide, thoria, iron oxides, silica gels, salts of difficultly volatile acids such as aluminium silicate and phosphate, and alkali silicates, borates, and aluminates, alone or in admixture with one another or upon supports such as pumice, asbestos, or active charcoal. The reaction product is rapidly cooled and the hydrocyanic may be liquefied or may be absorbed in active charcoal or alkalies or other absorbing media. The formamide or ammonium formate may be sprayed or allowed to trickle into a highly heated reaction chamber or may be caused to trickle on to a layer of catalyst in a quartz or metal tube. Suitable metals are, for instance, nickel, copper, and alloys of iron with nickel and chromium. Examples describe the use of quartz, pumice impregnated with thoria, aluminium phosphate, and pumice as catalysts. Specification 233,080 is referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

GALOXIDE.

474,883.—All goods in Class 1, but not including hydrogen peroxide, and not including any goods of a like kind to hydrogen peroxide.—Goodlass Wall & Co., Ltd., 42 and 44, Seel Street, *Liverpool. January 12th.*

LITHOTEX.

475,135.—Chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives. — Pictorial Machinery, Ltd., 7, Farringdon Road, London, E.C.1. January 12th.

AVOS.

471,474.—Chemical substances used for agricultural and horticultural, veterinary and sanitary purposes.—Albert Henry Brain, 63, Old Meeting Street, West Bromwich. January 12th.

DILAUDID BRAND.

475,65P.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Ltd., 3 & 4, Clements Inn, Kingsway, London, W.C.2. January 12th.

FRENCHMAN is prepared to give Lessons in French Grammar and Conversation.—Write, " C," c/o *Chemical News.*

ROYAL SOCIETY.

Government Grant for Scientific Investigations.

Applications for the year 1927 must be received at the offices of the Royal Society not later than March 31st next, and must be made on printed forms to be obtained from the Clerk to the Government Grant Committee, Royal Society, Burlington House, London, W.1.

FOR SALE.

Baker Steel Roll Refiners.—Particulars to Box No. C. B. B., c/o *Chemical News* Offices, Merton House Salisbury Square, London, E.C.4.

ANALYTICAL AND METALLURGICAL CHEMIST required immediately for Smelter in North of England. No previous experience in specialised work necessary. Must be young and energetic.—Apply, stating age, salary required, and details of experience to Box No. P. W. S., *Chemical News* Office, Merton House, Salisbury Square, London, E.C.4.

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A SELECTIVE DISPLACEMENT OF 0.0153A IN X-RAY SPECTRAL LINES.

By F. H. Loring.

In examining a number of emission X-ray line negatives, or spectrograms, it was observed that certain lines could be brought into the position expected from the known spectra of the elements present on the anticathode, or in the tube, by adding 0.0153A units thereto.

In examining J. S. Rogers' unidentified lines given by Siegbahn in his book "Spectroscopy of X-rays," 1925, p. 115, it was noticed that by the addition of the above value some of the lines could be brought into agreement with known lines. This is shown in the first section of the accompanying table.

Similarly, on examining the unidentified lines obtained by C. J. Lapp, R. A. Rogers and B. S. Hopkins (*Phys. Review*, 1925, XXV., 882), a certain agreement with known lines is made possible by adding the above value. This is shown in the second section of the table.

In the case of certain lines published in connection with the search for missing elements (F. H. Loring, *Nature*, 1926, CXVII., 448; *Chemical News*, 1926, CXXXII., 101), the same displacement is evident as shown by the third section of the table.

Finally, W. Noddack, Ida Tacke, and O. Berg's research in the field of missing elements (*Naturwissenschaften*, 1925, XIII., 571) gave lines which indicated the presence of elements of atomic numbers 43 and 75. So far as 43 (masurium) is concerned, there is a suggestive but uncertain agreement with the 2nd order lines of praseodymium, when the systematic error, above indicated, is introduced. This is shown in the fourth section of the table.

It cannot be suggested that the identifications indicated in the table are *all* favourable to the respective additions of the above value, 0.0153A, as a detailed study of the various lines on each negative would be necessary, but there is sufficient evidence on the whole to make the selective displacement indicated a matter worth following up in the writer's opinion. In the table, the x-line is, of course, the unidentified line, or the one in doubt. The gallium line in column 3 is calculated, as there is no 'Siegbahn-precision' value given, but Uhler and Cooksey's determination, 1.33785A, is supposed to be nearly correct. The praseodymium K lines are not very accurately known, but the figures used here are in agreement with the extrapolated values and these in turn are close to the best available determinations. Mean values are taken where brackets are introduced. The units are Angströms (A).

x-line	x-line + 0.0153	Identification.		Difference.
1.4503	1.4656	Ta$L\eta$	= 1.4655	+ 0.00010
1.3735	1.3888	Os$L\alpha_1$	= 1.38816	+ 0.00064
1.3212	1.3365 ?	Ga$K\alpha_1$	= 1.33711	− 0.00061
1.2487	1.2640 ?	Yb$L\gamma_1$	= 1.2648	− 0.00080
1.2300				
1.1138	1.1291	W$L\gamma_5$	= 1.1292	− 0.00010
1.0862	1.1015	Ta$L\gamma_2$	= 1.1020	− 0.00050
1.6927	1.7080 ?	Dy$L\beta_1$	= 1.70658	+ 0.00142
1.5878				
1.5486				
1.4501	1.4204	Dy$L\gamma_2$	= 1.4203	+ 0.00010
1.3753				
1.3604				
1.3441	1.3594	Ir$L\alpha_2$	= 1.35939	+ 0.00001
1.2487	1.2640 ?	Yb$L\gamma_1$	= 1.2648	− 0.00080
1.234 } 1.232 }	....	Hg$L\alpha_1$	= 1.2385	− 0.00550
1.032 } 1.029 }	.... 1.0458	Hg$L\beta_1$	= 1.0458	0.00000
1.434	....	Zn$K\alpha_2\alpha_1$	= 1.4340	0.00000
0.675	0.6903	IIPr$K\alpha_2$	= 0.6916	− 0.00130
0.672	0.6873	IIPr$K\alpha_1$	= 0.6830	+ 0.00430
0.601	....	IIPr$K\beta_1$	= 0.6030	− 0.00200

It will be seen from the table that the proper displacement, or systematic error, averages very closely to the value used, but a slight alteration of the value in and beyond the fourth place of decimals might be made.

Selecting the outstanding best agreements —1st, 5th, 8th, 9th—the average difference-value comes out at 0.01527. This value converted into a sort of oscillation frequency or wave-number ($10^8/\lambda$) is 6.5487 × 10^9. Though it should not be a separable quantity, it is related to Planck's constant, taken as 6.5487* × 10^{-27} in the ratio of 10^{36} to 1; but this is probably a chance coincidence, and any obscure relations of such a kind are of little interest without elucidation. Perhaps, however, it is worth noting that if the *plus* and *minus* differences are made respectively equal in number and magnitude (when added) in the two upper sections of the table—when excluding the more doubtful values as queried—then the displacement-value becomes: 0.015258A, this value gives the frequency number 6.554 × 10^9 (waves per cm.), but see above.

In conclusion, the possibility of meaningless coincidences with so many X-ray wave-lengths to select from must be taken into consideration, so that the idea here advanced is inconclusive except in so far as certain experiments by the present writer give definite support thereto. Moreover, in the best agreements, using the value 0.01527A the error falls in the 5th place of decimals (0.00007, 0.00002). This means perfect agreement, as the wave-lengths are not known far enough in the decimal region to make such errors significant.

Summary and Comment.

X-ray lines sometimes appear on spectrograms which seem to indicate that they are normal known lines displaced about 0.0153A unit towards the shorter wave-length side. The phenomenon, if it may be so regarded, seems to be selective in that lines of a given element may be normal except for one or two displaced the above amount. It is suggested that more work is necessary to

* The truer value is probably one of these: 6.554, 6.555, 6.556, 6.557. The average of the tabulated values as obtained by the use of X-rays, given by Siegbahn in his book, page 212, is 6.54. Birge (*Phys. Review*, 1926, XXVIII., 848) prefers the value 6.557. The mean between 6.54 and 6.557 is about 6.55.

establish such a shift on a firm basis, and the negatives should be examined to see whether the identified lines here given are supported by other normal lines in the region explored. No importance can be attached to the nearness of the 2nd order Pr lines (when including in two cases the displacement) to those of element of atomic number 43 (masurium) as none of the *K* values in question are known accurately enough to make a rigorous comparison. It is merely of interest to note the possibility of displacement in such cases.

RECENT CZECHO-SLOVAK CONTRIBUTIONS TO SCIENCE.

It is perhaps hardly realised how great a contribution has been and is being made to science by the Czechs. In a country which is very largely industrial, as their's is, research work is necessary in order to survive the competition of greater nations. This is recognised and their numerous modern technical and academic institutes and universities are contributing advances to the knowledge of pure and applied science, as may be seen from their technical journals.

During the last year a Chemical Exhibition was held in Prague and many important discourses were delivered. Prof. J. Heyrovsky read a paper on the Structure of Atoms and the Transmutation of Elements, in which he reviewed the various claims and possibilities of transmutation.

Prof. V. Vojtěch demonstrated the phenomena associated with fluorescence and photochemistry in a communication entitled "The External Structure of Atoms and Photochemical Reactions."

Prof. E. Votoček gave an important address on Modern Views on the Constitution of Simple Sugars. Dr. O. Tomiček showed some new developments in electrometric titrations and their application in analytical chemistry.

Among the more technical contributions mention may be made of the following: Czecho-Slovak Coals, by Dr. H. Novak; New Forms of Active Charcoal, by Dr. F. Nosek; and The Manufacture of Paraffin and Vaseline, by Dr. J. Kotrba. These papers were published in the *Chemické Listy*, the journal of the Czech Chemical Society. Recently the chemical engineers have started a publication of their own—*Chemické Obzor*.

One important contribution, "On Smokeless Powder," by Prof. C. K. Krauz, has been reprinted as a pamphlet. In it the author describes much original work. He had wide experience during the war as chief of the S.P. Department of the largest Austrian Explosive Factory at Blumau, near Vienna.

The text contains 106 original photographs covering the whole processes of the production of smokeless powder and the technical examination of its physical and chemical properties. It is probably the first complete account of smokeless powder ever published.

In the pharmaceutical journal *Časopisy Československé Lékárnictva*, Dr. H. Křepelka and J. Červinka have shown how to prepare hydrated magnesium peroxide. First of all ,hydrated peroxide of uncertain composition was obtained by the action of aqueous hydrogen peroxide on magnesium hydroxide. When a saturated ethereal solution of H_2O_2 is used the product is intermediate between $Mg(OH)_4$ or MgO_2 $2H_2O$ and the monohydrate. It will take up more water forming the di-hydrate. This on keeping, gradually decomposes into mixtures of magnesium peroxide, oxide and water. In a typical case the mixture had the composition $4MgO_2.2H_2O + MgO$.

If the peroxide prepared in ether is prevented from obtaining more water, oxygen is lost and indefinite mixtures were shewn to result.

In an entirely different branch of applied science, Prof. J. Peklo has described, as a result of a visit to this country, in 20 pages of the *Zemědělský Archiv*, a scientific study of British Agriculture and compared it with conditions in Bohemia.

He points out how the application of scientific principles has assisted British agriculture in difficult periods and he was especially struck by the applications of chemical and botanical knowledge. Both England and Czecho-Slovakia have to import much wheat and both are endeavouring to augment home supplies by crossing high quality wheats with prolific strains, as in Sweden.

Prof. Peklo considered barley production as almost as important as that of wheat. Czech barley is of the highest quality for brewing, but the stems are weak and the crops are easily beaten down by bad weather, thus making the yield low. The author was, therefore, very interested in English hybrids which would be proof against "dropping," and yet would maintain a good quality.

Whilst Zatec (Bohemia) hops are well-known for their high quality ,most attention to hop-growing is given in England, especially Kent.

Potatoes are consumed in greater quantity in Bohemia than in England, as less green vegetables are used. English growers devote more care and attention to potato cultivation than continentals, whose backwardness is partly attributed to unsettled political conditions. Prof. Peklo goes into the genetics of potato diseases. He visited the North of Scotland and the Hebrides in the course of his investigations. He finally describes English work in connection with the making of cider, the storage of apples, and the improvement of grasses as carried out in Wales. His descriptions are in an emphatic tone and should be of even more interests to botanists than chemists, especially the accounts of the Kew, Glasgow and Edinburgh Botanic Gardens.

J. G. F. Druce.

A FUNDAMENTAL BASIS FOR MEASUREMENTS OF LENGTH.

By H. W. Bearce.
(U.S.A. Bureau of Standards.)

Abstract.

1. *Relation between yards and meters, inches and millimeters.*—There is at present a slight difference in the legal or official relation between yards and meters in the United States and in Great Britain. In the United States the official relation is

$$\frac{1 \text{ yard}}{1 \text{ meter}} = \frac{3,600}{3,937}$$

In Great Britain the official relation is

$$\frac{1 \text{ yard}}{1 \text{ meter}} = \frac{3,600}{3,937.0113}$$

From these official relations may be derived the following approximate relations,
1 United States inch = 25.40005 millimeters
1 British inch = 25.39998 millimeters

While this difference in the units is so small as to be of no importance in the ordinary transactions of everyday life, amounting as it does to about 1 part in 363,000, it is of great impotrance in the more precise length measuerments of science and industry, where an accuracy of 1 part in 1,000,000, or even higher, is not uncommon. It is obvious that conversions between yards and meters, inches and millimeters, can not be made with a higher precision than that to which the relation between the units is known.

2. *Definition of the meter in terms of light waves.*—The paper recommends that the meter be defined in terms of wave lengths of light from cadmium vapor, under standard conditions of temperature, pressure, and humidity, on the basis of the determinations of Benoit, Fabry, and Perot.

3. *Acceptance of simple relation between yards and meters, inches and millimeters.*—The paper recommends the adoption of the simple relation 1 inch = 25.4 millimeters. If this relation is adopted as exact, then the corresponding relation, 1 yard = 0.9144 meter, will also be exact.

4. *Definition of the yard in terms of light waves.*—If the meter is defined in terms of light waves, and the relation between the meter and the yard is fixed, then the yard is automatically defined in terms of light waves. For example, if 1 meter = 1,553,164.13 waves and 1 yard = 0.9144 meter, then 1 yard = 0.9144 × 1,553,164.13 = 1,420,213.28* waves.

5. *Simplicity and international uniformity.*—Official action by the United States defining the yard and the meter in terms of light wave, and adopting the relation 1 inch = 25.4 millimeters as exact, would not only give official sanction to a simple and convenient relation already widely used in both the United States and Great Britain, but would tend to bring about its universal adoption. This value lies between the values now legal in the United States and in Great Britain, and it could, therefore, be acecpted by both without inconvenience. In fact, the change

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* In cutting this value off to two decimal places the error introduced does not exceed 1 part in 3,000,000,000.

would never be felt except in cases of extreme accuracy, such as the manufacture and testing of precision end standards and graduated linear scales.

RELATION OF UNITS.

In order that measurements of length may be comparable they must be expressed in terms of a single standard or in terms of standards bearing a known relation to each other.

Lengths are ordinary expressed in terms of yards or meters or some multiple or subdivision of these units.

The following units and their appropriate abbreciations, or smybols are often used for expressing lengths of small magnitude :—

Micron = μ = 0.001 millimeter = 10^{-3} mm.

Millimicron = $m\mu$ = .000001 millimeter = 10^{-6} mm.

Angstrom = A = .0000001 millimeter = 10^{-7} mm.

Milliangstrom = mA = .0000000001 millimeter = 10^{-10} mm.

In general, the relations between the various units of any given system of measurement are relatively simple and are well known; for example, the relation between inches, feet, yards, and miles; and between millimeters, centimeters, meters, and kilometers. On the other hand, the relations between the various units of different systems of measurement are, in general, not so simple or so well known; for example, the relation between inches and millimeters, yards, and meters, miles, and kilometers.

Comparison of lengths expressed in the two systems of measurement in common use is further complicated by the fact that no single basic relation between the units of the two systems is at present universally recognised.

In the United States the basic relation officially recognised is that contained in the law of July 28, 1866, and set forth in the Mendenhall order of April 5, 1893; namely,

$$\frac{1 \text{ yard}}{1 \text{ meter}} = \frac{3{,}600}{3{,}937}$$

In Great Britain the present basic relation is that contained in the Order in Council of May 19, 1898, namely,

$$\frac{1 \text{ yard}}{1 \text{ meter}} = \frac{3{,}600}{3{,}937.0113}$$

This slight difference in the legal relation between the units of the customary and the metric systems, although of no importance in the ordinary transactions of everyday life, is of very great importance in the more precise measurements of length required by present-day science and industry.

Prior to 1893 the United States yard was regarded as identical with the British yard and any deviations found were regarded as errors in the United States standards. Since 1893 the United States yard and its subdivisions have been derived from the international meter by means of the relation contained in the law of 1866 and set forth in the Mendenhall order already referred to. This change in policy on the part of the United States followed the receipt of the metric standards and the recognition of their superiority, from the standpoint of accuracy and permanency, over the standards previously available.

BRITISH STANDARD OF LENGTH.

The present primary standard of length of Great Britain—the British imperial yard—was made in 1845, and was adopted as the primary standard of length in 1855. In 1878 this imperial yard was continued as the primary standard and the relation between the yard and the meter was established† as

$$\frac{1 \text{ yard}}{1 \text{ meter}} = \frac{3.600}{3{,}937.079}$$

In 1898 the relation between the yard and the meter was changed to

$$\frac{1 \text{ yard}}{1 \text{ meter}} = \frac{3.600}{3{,}937.0113}$$

this relation being based on comparisons carried out at the International Bureau in 1894 by Benoit. That relation still stands as the official relation between the British yard and the meter, but it has been informally announced, and unofficially published, that recent comparisons have shown that the actual relation at the present tims is

$$\frac{1 \text{ yard}}{1 \text{ meter}} = \frac{3{,}600}{3{,}937.0131}$$

It may well be asked, " How can it be said with certainty that this changed relation has not been caused by a change in the standard meter rather than by a change in the standard yard? " In answer it must be admitted that it can not be said with certainty, but that the evidence is overwhelmingly in favour of the belief that most, if not all, of the change is attributable to the yard.

† This relation follows from the equivalent, 1 dekameter = 10 yards 2 feet, 9.7079 inches, which is contained in the law.

Adoption of a Single Basic Standard Recommended.

The universal adoption of a single basic standard of length, and the derivation of all other standards from this through the adoption of a fixed relation of units ,would seem to offer a means by which we might emerge from our present dielmma.

The following is suggested as a feasible gasis for such action :

In 1893 the number of wave lengths of the red radiation from cadmium vapour equivalent to a length of 1 meter was very accurately determined by Michelson. Fourteen years later the determination was repeated by Benoit, Fabry, and Perot, and the results obtained were in agreement with Michelson's value when reduced to the same basis, to better than 1 part in 15,000,000.

Conclusion.

It is recommended that the meter and the yard be defined in terms of light waves from red cadmium vapour under standard conditions of temperature, pressure, and humidity, the meter being defined directly on the basis of the determinations of Benoit, Fabry, and Perot, as equal to 1,533,164.13 wave lengths and the yard being defined as equal to 1,430,213.28 wave lengths through the acceptance of the relation

$$1 \text{ yard} = 0.9144 \text{ meter}$$

Under the Constitution of the United States, Congress has power. . . "to fix the standard of weights and measures." The fixing of the yard and meter in terms of light waves is therefore clearly within the field appropriate for congressional action.

The action proposed would result in the adoption of a yard differing slightly from both the present United States yard and the British yard and lying between them, and in the continuation of the meter without change. If taken by the United States alone, this action would reduce the difference between the units of length now legal in the United States and in Great Britain to about two-sevenths of its present value. That in itself would be a notable achievement. Furthermore, in the event of such official action on the part or the United States, it might reasonably be expected that similar action would be taken by Great Britain, thus bringing about complete uniformity in the units of length of the two countries.

Among those who have succumbed to the recent ravages of influenza is Dr. W. W. Seton, D.Litt. (Lond.), D.Ph. (Prague), Secretary of University College, London.

SOUTH AFRICAN CHEMICAL INSTITUTE.

(*Continued from Page 62, January 28.*)

The clear juice is evaporated down in a train of multiple effect vacuum evaporators, of which after being concentrated down to a 50 per cent. solution, is ready for the final evaporation in single-effect vacuum pans to crystallise out the sugar. This is an operation calling for considerable skill and experience in controlling the rate of boiling and admission of fresh liquor so as to maintain the even grain of crystal which is required to attain a pure and uniform product. The mass of crystals and mother liquor known as massecuite is discharged from the vacuum pan into large horizontal cylinders, and there kept in constant motion by rotary stirrers until cooling and crystallisation is complete. The mass is then run into centrifugal machines, where the crystals are separated from the adhering mother liquor (molasses). The molasses is boiled again after having been admixed with fresh syrup until finally a liquor is obtained from which no more sugar can profitably be extracted. The molasses or treacle then contains about 40 per cent. sucrose and 55 per cent. total fermentable sugars and 15 per cent. water, and is discarded from the sugar process, usually being used in the fermentation industry as a source of alcohol, or sometimes as a fertiliser or foodstuff for stock, or rarely as a fuel. In 1924, 2,200,000 gallons of alcohol were made from Natal molasses, of which only 82,000 gallons, or less than 4 per cent., was used as so-called cane spirit or rum, the balance, over 2,100,000 ballons, being used for industrial purposes.

The sugar separated in the centrifugals is discharged into a conveyor; in some cases the centrifugals have no bottoms, so that the sugar is discharged automatically into the conveyor below as soon as the machine stops and the centrifugal force holding it is thereby removed. If the sugar is intended for the refinery, it is sometimes bagged without further operation, but more usually, especially if intended for direct consumption, is passed through a drying operation, frequently performed in a large rotating drum set nearly horizontally and through which a current of heated air is passed. The refining process as generally understood is essentially one of decolourisation by some form of carbon, which may be either a bone charcoal or an activated vegetable carbon derived from almost any waste organic matter, rice hulls, seaweed, paper pulp, and

bagasse all having been successfully used. The bon char process is by far the oldest established, but requires for its successful operation a large plant, and is therefore usually established on a large scale at the principal seaports of the large consuming centres, and operates on imported raw sugars, hence the synonym "cargo" sugar for this raw material.

Vegetable carbons can also be used successfully in large central refineries, but find their principal applications in small plants attached to a sugar factory intended to deal primarily with the product of that factory alone. The vegetable carbons are much more active ,weight for weight, than bone char as decolourising agents, but it is claimed that they are not proportionately effective in removing mineral impurities by absorption.

In either case the process is very simple; the raw sugar is dissolved in water, and the solution in the case of bone charcoal allowed to flow through towers packed with the char until entirely decolourised, when it is evaporated and crystallised as in the original manufacture; while with a vegetable carbon the charcoal is added with or without some filtering aid, such as the kieselguhr, and passed through a filter press, after which the evaporation, etc., is the same as above. The carbon is usually revivified by heating in a furnace specially designed for the particular kind of carbon in use. Sugar made by the carbonatation process is now accepted as refined sugar, although it would perhaps be more accurately described as sugar made of a quality equal to the best, refined in one series of operations, so that a second process is not necessary. It consists essentially in adding excess of lime to the raw sugar juice, and then precipitating the excess by means of carbon dioxide, whereby a dense flocculent precipitate of calcium carbonate is formed, which carries down practically all the suspended and oloured impurities in the juice. The process of double carbonatation, as the name implies, is carried out in two stages, the second application of carbon dioxide being made after filtration. The juice is then heated to 70° C., and again filtered. The carbonatation process was first applied in the beet sugar industry, and obviously requires a cheap and sufficient source of limestone of good quality, the want of which locally is often a bar to its application.

It will be seen that there is much to interest and engage the attention of the chemist and the engineer in the manufacture of sugar, which is perhaps the only article of diet which is a definite individual substance supplied in a state of chemical purity, the sucrose content of refined sugar being usually about 99.9 per cent. Both the industry and those manufacturers dependent on it, such as preserved fruits and jams, confectionery, condensed milk, pharmaceutical preparations, and alcohol and motor spirit, are of such vital importance to the community, that every country should be, if practicable, self-supporting to some extent in sugar production. I hope that this brief outline of method of manufacture has been of interest to you, although written descriptions of manufacturing processes can seldom be made very graphic. If any of you should visit the Natal coast during the months of May to December, I will have great pleasure in arranging a visit to a sugar factory, should you so desire.

General Notes.

HUNGARIAN FOREIGN TRADE.

An adverse trade balance amounting to 71,590,000 gold crowns was recorded during the first eleven months of 1926—imports and exports totalling 743,822,000 crowns and 672,232,000 crowns respectively.

SHIPS LAUNCHED AND AFLOAT IN 1926.

According to Lloyd's Register Annual Summary of Shipbuilding 600 vessels of 1,674,977 tons gross were launched last year, towards which Great Britain and Ireland contributed 639,568 tons, or 38.2 per cent. The gross tonnage of seagoing steel and iron steamers and motorships at June last amounted to 59,117,000 tons, of which vessels fitted for oil fuel accounted for 18¼ million tons, tankers for 5,665,000 tons and motorships for 3½ millions tons.

BRITISH IRON AND STEEL OUTPUT IN 1926.

During December 71 furnaces were put in blast, bringing the total working to 78 as compared with 147 at the end of April.

The past year's output of pig iron was 2,4451,500 tons as against 6,261,700 tons in 1925, and the production of steel ingots and castings 3,560,400 tons against 7,385,400 tons.

PROGRESS IN COAL MINING.

For the week ending January 1, 1927, 966,700 coal miners were at work and produced 5,025,300 tons of coal, the largest figures since the termination of the strike.

IMPERIAL CHEMICAL INDUSTRIES EXHIBIT AT THE BRITISH INDUSTRIES FAIR.

Further details are to hand concerning the exhibit organised by Imperial Chemical Industries at the British Industries Fair, February 21 to March 4, on Stand A.10, in the Chemical Section.

The exhibit will include the principal chemical and allied products made by this important group of companies, which it will be remembered consists of a merging of the interests of Brunner Mond & Co., Ltd., Nobel Industries ,Ltd., The United Alkali Co., Ltd., and the British Dyestuffs Corporation, Ltd.

A large stand measuring over 1,200 square feet has been designed, and will consist essentially of a series of steps (from an exterior point of view) on which will be seen the products of the various companies. Two imposing entrances will lead into a hall where exhibits showing the wide influence of the companies will be inspected by the visitors at their leisure, and this hall will provide a conference room for the exhibitor's representatives and enquirers. In it will be a specially arranged office for the convenience of those making confidential enquiries.

From an exterior point of view the public will be able to visualise by means of a flow sheet (on which the actual articles will be shown) the inter-connection of the various companies, and the inter-alliance of their various products in almost every industry in the world. For example, coal is one of the sources of Britain's wealth—Imperial Chemical Industries will show how coal (which is not only used for fuel) is also the basis of numerous other products.

Similarly, Brunner Mond and Co., Ltd., will show how salt as a basic raw material is treated and how it forms a base for other commodities. Nobel Industries, Ltd., will have an attractive display of all their products, while the British Dyestuffs Corporation are showing in a practical exhibit some of the mysteries of the manufacture of dyes and colours.

The companies comprising Imperial Chemical Industries have already supplied the Board of Trade with a large number of possible buyers in all parts of the world and invitations have been despatched by the Government to these names and addresses.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Faraday Medal.

The Council of the Institution of Electrical Engineers have made the Sixth award of the Faraday Medal to Professor Elihu Thomson, of Boston, U.S.A., Honorary Member of the Institution, who is well known as one of the pioneers in the development of electrical engineering.

The Faraday Medal is awarded by the Council of the Institution not more frequently than once a year either for notable scientific or industrial achievement in Electrical Engineering or for conspicuous service rendered to the advancement of electrical science without restriction as regards nationality, country of residence, or membership of the Institution.

LARGE ORDERS FOR BRITISH FIRM.

The Great Southern Railway of Ireland, the principal railway company in the Free State, have decided to equip their main line depots at Inchicore, Ballybrophy, Limerick and Cork with water softening installations of the most modern and scientific type, and have placed the entire order for this work with a British firm, United Water Softeners Limited, of London.

The provision of softened and purified water for the locomotives throughout the system will effect substantial economies in respect of fuel consumption and repair bills, and render possible a great increase in engine mileage between cleanings.

The Sudan Government Railways and the Great Indian Peninsular Railway have also placed orders for softening installations with United Water Softeners, Ltd., the water softener adopted in all three cases being the well-known Lassen-Hjort lime-soda system, already used on British Railways.

THE DENSITIES OF CERTAIN BINARY LIQUID MIXTURES AT 25° C.

(*Chemical News*, 1927, CXXXIV., 36.)

The author, R. M. Woodman, points out that the heading " Pyridine-Water Mixtures " over Table 2, should read "Pyridine-

Benzene Mixtures." It was correctly stated in the copy, but the error escaped the attention of the proof reader.

A NEW ANTI-DIABETIC.

The discovery of a new drug that will act either as a substitute for insulin or as an auxiliary to it is an important recent biochemical achievement.

Professor Minkowski, of Breslau, showed in 1889 that the removal of the pancreas from animals caused severe diabetes, though it was not until thirty years later than Banting and Collip isolated insulin.

The chemical nature of insulin has not yet been discovered. The drawbacks to its use consist in the fact that it must be given daily, and can only be administered by subcutaneous injection. The new drug can be taken by the mouth, and is absorbed from the digestive tract. Its effects in lowering the blood sugar are similar to those of insulin, but more slow.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting on Thursday, January 27 ,1927 :—

The Effects of the Ovarian Hormone in Producing Pro-Œstrous Development in the Dog and Rabbit. By S. A. ASDELL AND F. H. A. MARSHALL, F.R.S.

Injections of follicular extract obtained from solution in alcohol produce typical proœstrous changes in the uterus of the bitch during the anœstrous period (that is, at a time when the uterus is normally quiescent).

Injections of the extract likewise cause a growth of the vaginal epithelium followed by a breaking down of the cornified cells.

Changes can be brought about similarly in the uterus and vagina of the rabbit.

In the experiments described no definite œstrus was experienced by either the bitches or the rabbits, and there was no swelling of the vulva; it is possible, therefore, that in the actual production of œstrus a further factor may be involved.

Experiments on the Egg-Laying Instincts of the Sawfly Pontania salicis Christ. *and their Bearing on the Inheritance of Acquired Characters, with some Remarks on a New Principle in Evolution.* By J. W. H. HARRISON. Communicated by Prof. E. W. MacBride, F.R.S.

The gall-making sawfly *Pontania salicis* possesses local races, each with its own special species of *Salix* as its food-plant. Direct experiments proved that the instinct to oviposit on such special species was inherited. By compelling a *Salix Andersoniana* race of *P. salicis* to lay its eggs on the hybrid willow *Salix purpurea* × *S. viminalis* over a period of years, the habit of choosing that hybrid as food-plant was developed and germinally fixed. This was proved by experimental attempts to throw it back once more on *Salix Andersoniana.* In other words, we have a clear case of the Inheritance of Acquired Characters.

Coupling these results with those on the Induction of Melanism in the Lepidoptera (Harrison and Garrett, 1926) by chemical means, a new principle of evolution on the basis of direct chemical influences on the germ-pasm, whether in the form of the compulsory taking of new food-plants, changed soil conditions, or otherwise, is developed.

The History of the Cytoplasmic Inclusions of the Egg of Ciona intestinalis (L) *During Oogenesis and Fertilisation.* By L. A. HARVEY. Communicated by Prof. E. W. MacBridge, F.R.S.

Previous accounts of yolk formation are reviewed briefly.

In *Ciona intestinalis* mitochondria are present at chromophobe vesicles with acidophil auræ in the youngest oocytes. They increase in number enormously, and practically all except those in the narrow peripheral layer swell to form yolk. After extrusion of test cells the remaining mitochondria become granular and uniformly acidophil. The peripheral layer forms a deep cup, which becomes shallower and thicker at the time of fertilisation.

The Golgi apparatus passes from primary diffuse to complex, and then to secondary diffuse stage. It consists always of small argentiphil vesicles and irregular masses.

It is suggested that the "yolk nucleus" is secreted by the Golgi apparatus very early in oogenesis. It fragments and becomes dissolved in the cytoplasm.

The test-cells pour lipoid materials into the egg during yolk formation.

The cytoplasm passes from primary oxyphily to basophily and then to secondary oxyphily. These changes are correlated with changes in the Golgi apparatus, as described by Hirschler.

The germinal vesicle bursts and the reconstituted nucleus reaches the metaphase of the first maturation division usually before the egg leaves the ovary.

The Measurement of Pencentage Hæmolysis.—II. By E. Ponder. Communicated by Sir E. Sharpey Schafer, F.R.S.

This paper is devoted to a detailed analysis of the form of the percentage hæmolysis curves for the simple lysins, acting alone, with accelerators, and with inhibitors.

Two methods for investigating the curves are described; the first is a modification of the radiometer method published in 1924, and the second one using the resistance of selenium as a measure of the light passing through the cell suspension.

It is shown that the form of the percentagehæmolysis curves, for systems in which the lysin is acting alone, can be exactly explained by the assumption that a monomolecular reaction proceeds among a population whose resistances are distributed according to a frequency curve, usually of Pearson's Type II. The lysins dealt with are saponin and sodium taurocholate; the method of analysing the curves is given in full, with examples from experiment.

The cases where (*a*) an accelerator is added to the system before the reaction begins, (*b*) an accelerator is added after the reaction has commenced, (*c*) an inhibitor is added at the commencement of the reaction, and (*d*) an inhibitor is added after the reaction had begun, are considered. It is shown that the effect of the accelerators and inhibitors is to alter the resistance of the population to the lysin, the alteration of resistance being described by an expression containing the single resistance constant, R.

33,000-VOLT CABLES WITH METAL-SHEATHED CORES, WITH SPECIAL REFERENCE TO THE S.L. TYPE.

By Percy Dunsheath, O.B.E., M.A., B.Sc.
(*Before the Institution of Electrical Engineers.*)

Summary.

The troubles that are being experienced in the use of plain 3-core cables for working at 33,000 volts are referered to and the theories advanced in explanation discussed. The various types of multi-core cable with metal sheaths over the individual cores are then enumerated and their advantages over the plain 3-core type detailed. The claims of the S.L. type in which each core is separately lead-covered, over the other metal-sheathed core types in which a common lead sheath covers all three cores, are explained. The paper gives practical formulæ for calculating sheath effects in single-core cables, together with the results of a series of tests carried out to determine the extent of these effects in the S.L. type. Consideration is given to the temperature-rise in the various types, along with the results of a series of heating tests. As the employment of the S.L. type of cable is a move in the direction of employing single-core instead of 3-core cable, this question is also discussed and results of loading tests on both plain lead and armoured single-core cables are given. The mechanical properties of the S.L. type are also investigated and in the conclusions at the end of the paper is shown that the presence of the sheaths, in addition to having well-known electrical advantages, produces a very distinct improvement in the thermal properties of the cable and results in a construction which is very much sounder, both mechanically and electrically, than other systems of multi-core supertension cable.

General Conclusions.

Metal-sheathed core cables have many important advantages over plain 3-core cables, and practically no disadvantages. Of the two types of metal-sheathed-core cables, the S.L. type has important advantages over the non-S.L. type, but has been considered to have disadvantages because of the voltage generated and losses incurred in the sheaths surrounding the separate cores. A wide range of tests shows conclusively that these fears are groundless. The voltages are very small, even when not suppressed by bonding, and when the cables are bonded together the losses due to eddy currents are negilgible. Also, contrary to the previous supposition that the losses reduce the rating of the cable by the heat generated in the sheaths, the cooling effect of the sheaths carries the balance far in the opposite direction, resulting in the S.L. type of cable running very much cooler than the plain 3-core cable. Considering also that the S.L. cable is lighter in weight than the plain 3-core cable and carries with its use a very simple joint construction, in addition to the known electrical advantages, it seems that an unanswerable case is made for its use as a solution of the 33,000-volt cable problem.

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on Tuesday, January 18, Prof. H. Hilton in the chair :—

The Temperature-Range of Formation for Tourmaline, Rutile, Brookite, and Anatase in the Dartmoor Granite. By DR. A. BRAMMALL AND DR. H. F. HARWOOD.

Applying Write and Larsen's conclusions concerning rock types in which quartz originated in the α- or the β-phase, the authors adduce petrological evidence to support the following approximations : The range for tourmaline extends from magma-temperatures circa 800° downwards through an " optimum " range circa 600°-300° into an unfavourable range with an undetermined lower limit. The range for rutile is at least co-extensive with that for tourmaline. The range for anatase extends downwards from temperatures connoted by crystallisations from small residual pools of borosilicate flux accumulating at a late stage in the consolidation of the granite groundmass, to temperatures at which simple hydrolysis of biotite occurs. The range for brookite lies within that for anatase. For each species, extension of the range downwards may prove to be necessary in order to cover cases of suspected authigenic growth in sediments.

Notice of an Occurrence of Niccolite and Ullmannite at the Settlingstones Mine, Fourstones, Northumberland; of Stichtite at the Island of Unst, Shetlands; and of Seprierite at Ross Island Mine, Killarney, Co. Kerry, Ireland. By A. RUSSELL.

In 1924 during the working of a body of galena in the witherite vein of Settlingstones mine, a small quantity of very rich niccolite intimately associated with ullmannite, blende, galena and witherite, was met with. Polished sections of the ore show the niccolite in roughly spherical to botryoidal forms, often surrounded by fringes of ullmannite and associated with brown blende and white witherite. Minute cubes of ullmannite occur in the witherite. Stichtite occurs in characteristeric fibrous lilac coloured specimens associated with kämmererite and chromite in serpentine at the " Kämmererite Quarry," Nikka Vord, Balta Sound, Island of Unst, Shetlands. The rare mineral serpierite occurs in cavities in cellular calamine ($ZnCO_3$) on the old dumps at Ross Island Mine, Killarney, Co. Kerry. Ireland. It forms small greenish-blue spherical aggregates composed of minute crystals flattened parallel to c(001) and elongated in the direction of the a axis.

ROYAL INSTITUTION.

On Tuesday last, February 1, at 5.15, Professor Julian Huxley, Fullerian Professor of Physiology, began a course of six lectures at the Royal Institution, on " Animal Growth and Development "; on Thursday, February 3, at the same hour, Sir William Bragg delivered the first of three lectures on " Acoustical Problems treated by Lord Rayleigh : (1) Æolian Tones; (2) Echoes; and (3) Bells "; and on Saturday, at 3 o'clock, Mr. Walter de la Mare will commence a course of three lectures on (1) " Craftsmanship in Verse," (2) " ' Atmosphere ' in Fiction," and (3) " The Supernatural in Fiction."

The Friday Evening Discourse on February 4 will be delivered by Professor E. V. Appleton on " Wireless Transmission and the Upper Atmosphere "; on February 11 by Mr. Ernest Law on " Old Hampton Court Palace Revealed "; and on February 18 by Sir osiah Stamp on " The Laws of Monetary Science."

CORRESPONDENCE.

CONDENSATION PRODUCT OF ACETYLENE AS A CATALYST.

(*To the Editor of the* CHEMICAL NEWS.)

Sir,

During the course of a series of experiments on the effect of various catalysts on the condensation of acetylene, conducted in March, 1925, by Mr. G. W. Acheson and the writer, a yellowish or brown fluffy inert solid was obtained. This material is apparently similar to that described in Mr. Loring's article on " A New Condensation Phenomena (*Chemical News*, December 31, 1926, p. 419), in which he refers briefly to a condensation product of acetylene obtained with the new Coolidge vacuum tube.

In one of our experiments we passed acetylene gas through a copper tube which was heated at one point with a blow torch.

A poor yield of liquid hydrocarbons was obtained and the clogging of the copper tube with tightly packed carbon which was thrown out of combination frequently necessitated the interruption of the experiment. A rod used to pry out the carbon was quite inefficient due to the tenacious adherence of the soot to the metal tubing. To clean the tube thoroughly the carbon was burned out.

The apparatus was again assembled and the experiment continued, only to again be interrupted by the troublesome clogging,

which resulted in the discontinuation of the run and the ultimate cleaning of the tube. This time, instead of finding soot, a yellowish or brown fluffy powder was removed, which showed great reluctance to react chemically.

Mr. Acheson attributed its formation to the catalytic effect of the copper oxide formed in burning out the tube and to confirm his belief, repeated the experiment, substituting a hard glass tube for the copper one previously employed. A few grams of copper filings were introduced into the tube at the point where heat was applied and upon the passage of acetylene, free carbon was seen to rapidly accumulate, duplicating the results first obtained with the metal tube. Black copper oxide was then used in place of the copper filings, and upon duplicating the conditions of the previous run, the brown fluffy solid formed about the catalyzer rapidly.

Although interest in the product was great, the purpose of the experiments took us along other lines, preventing us from making further tests or searching the literature. Mr. Loring's article recalled the formation of a similar substance in our previous work, and I cite the method of its formation should one care to duplicate the experiment for the purpose of comparing its product with that obtained with the new Coolidge tube.

Very truly yours,

RAYMOND SZYMANOWITZ.

Forest Avenue,
Caldwell, New Jersey.

NOTICES OF BOOKS.

A PHOTOGRAPHIC ANNUAL.

The 62nd annual issue of the *British Journal Photographic Almanac** has just made its appearance and will be welcomed by all interested in photography. It is a bulky volume of 820 pages, of which nearly half is occupied by the text and is illustrated with numerous photogravure plates of a high quality.

Recent photographic products — new cameras, lenses, plates, films, and other apparatus—are adequately reviewed by Mr. G. E. Brown, who has now been the editor for twenty years, and this forms a valuable feature of the work. The amateur will be specially interested in the article explaining the many ways in which a reflex camera simplifies the taking of photographs, and he will also find much useful information in the article on trimming, mounting and framing.

Pharmaceutical chemists and druggists will all probably read Thermit's "D. and P. and the Chemist," which gives an inside view of the developing and printing business.

In the reviewer's opinion, the most valuable portion of the *Almanac* is the "Epitome of Progress," which occupies 80 pages.

The past year has not been remarkable for any outstanding discovery or marked advance, nevertheless steady progress has been made, especially in the manufacture of extremely rapid lenses. T. Thorne Baker has published details of the transmission of ultro-violet light by various lenses, which show that the more complex ones have a lower rapidity.

Desensitising has been studied by many investigators. J. I. Crabtree, and M. L. Dundon, for instance, find that the desensitising effect of pinacryptol green is nearly proportional to the strength of the bath and increases with temperature. Most of the action occurs in the first two or three minutes. The exposure of a desentised plate to bright red light may cause partial destruction of the latent image. Pinacryptol green promoted fog with pyro-soda, but not with glycine developer.

A. and L. Lumiere and A. Seyewetz have used dye-toning for the intensification of negatives and have devised a process whereby prints on development papers may be dye-toned without appreciable staining of the paper.

All this and much more is to be found in the *B. J. Almanac* for 1927.

J. G. F. D.

The Magnesian Flooring Materials Association, 106, Fenchurch Street, E.C.3., has just issued an interesting brochure, *Composition Floorings* Facts in relation to jointless Flooring and Magnesian Composition.

It has long been known that when magnesium oxide is added to magnesium chloride solution, a very hard oxychloride is produced. These, and a "filler," constitute the ingredients of the new jointless flooring

* *The British Journal Photographic Almanac*, 1927. Ed.: George E. Brown, F.I.C. 820 pages and 32 pages of photogravure supplements. London: Henry Greenwood & Co., Ltd., 24, Wellington Street, W.C.2. 2s. net (paper covers); 3s. net (cloth bound).

which possesses many advantages over the older ones.

Tests have been made to show its superiority in wearing qualities and it is more resilient than most other surfaces. Investigations are in progress, we are told, with the object of finding the best methods of tinting the flooring. When these have been ascertained, a promising future seems assured for such jointless floorings.

The latest section of *Tables Annuelles de Constantes et Données Numériques* to be published is Volume V—Numerical Data for Engineering and Metallurgy, by L. Descroix. It has a preface by Sir Robert Hadfield. The volume covers the years 1917-1922, and occupies 245 pages, containing all the documents relating to engineering and metallurgical constants which appeared during those years. The price is 126 francs bound, 105 francs unbound. Members of certain Scientific Societies can obtains a small reduction in price. Applications should be made to Dr. C. Marie, 9 Rue de Bagneux, Paris, VI.

Catalogue of Optical and General Scientific Instruments shown at the Optical Convention, 1926. Pp. 336. Price 6s. net. (Inland postage 9d. extra.).

The Exhibition to which this Catalogue relates was held in connection with the Optical Convention, at the Imperial College of Science and Technology, South Kensington, London, S.W.7., in April last. The book is intended as a permanent work of reference to British optical manufactures at the time of the Convention, and contains full illustrated descriptions of the instruments and apparatus exhibited by the leading makers in Great Britain. It is indispensable to all users of optical appliances.

Descriptions of the Experimental and Research and Historical exhibits at the Convention are also given.

U.S. USES BILLION WORTH OF GAS.

The United States is consuming gases at the rate of a billion dollars a year, according to a report of ten years of progress in that industry made public here by the American Chemical Society (says *Chemicals*).

" It is one index to the progress of civilisation that we have been able to create, out of an intangible and largely invisible and inponderable substance, so great a commercial asset," says the report, prepared by Otto Wilson, foreign trade expert of Washing, D.C. Marked advances are predicted for 1927.

Striking testimony to the money value of chemical research, it is added, is found in the liquefied and compressed gas industries, whose yearly output has increased in value in the last decade from $10,000,000 to $54,000,000.

Helium Advances.

" The service rendered by industrial and commercial gases is just beginning. Helium is one of the gases that has made the most striking advance as a commodity.

" The overnight metamorphosis of helium from the status of an extremely expensive laboratory gas to that of a large-scale commodity is one of the curiosities of applied science," it is declared. " Before 1915 the rare ' gas of the sun ' was valued at $1,500 to $2,000 a cubic foot. During the war some 140,000 cubic feet of helium were made ready for shipment to Europe, although none was actually sent. After the war the conservation of helium lapsed for a while, but was later resumed, and the Government now has many million cubic feet stored in tanks as a military reserve.

" It has also definitely taken over the production of helium and adopted an effective conservative policy. Strictly speaking, helium is not, therefore, a commercial commodity, although the law authorises the leasing or surplus supplies to American concerns. The cost of extracting helium has been greatly reduced since the war.

Nitrous Oxide a Leader.

" Nitrous oxide, one of the first anæsthetics, has continued to the present to be a leader in that field, and production to-day is greater than ever before. It is more or less concentrated, twelve plants turning out all the 45,297,000 gallons marketed in the U.S.A.

" Hydrogen, the balloon gas, has been turned out in greatly increased quantities since the war, part of the production going into other employments besides aeronautics, such as the hydrogenation of oils, reduction of metals and use in the oxy-hydrogen torch.

" Firty-one establishments in the United States, according to the most recent figures, are producing 103,818,000 cubic feet of hydrogen, valued at $695,000. Only 1,669,000 cubic feet were produced in 1914.

"Of the many other gases which have attained a position on the country's market-place, few have failed to feel the quickening influence of the great commercial and industrial activity of the years since the war.

"Chlorine, now widely used as a purifier of city water in addition to its established use in bleaching compounds, is produced to the extent of 125,000,000 pounds, a gain in two years of more than 60 per cent.

"Sulphur dioxide, another bleaching agent and disinfectant, is finding new fields, especially in medicine. Of carbonic acid, some 51,000,000 pounds were manufactured in 1923 for the soda fountains and bottlers of soft drinks, the value being almost $5,000,000."

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

Thursday, February 10, at 4.30 p.m.—The following papers will be read :—

"The Photographic Action of β-Rays." By C. D. Ellis and W. A. Wooster.

"The Relative Intensities of the Groups in the Magnetic β-Ray Spectra of Radium B and Radium C." By C. D. Ellis and W. A. Wooster.

"An X-ray Investigation of Certain Long-Chain Compounds." By A. Muller.

And other papers.

The following papers will be read in title only :—

"Measurements of Ozone in the Earth's Atmosphere and its Relation to other Geophysical Conditions. Part II." By G. M. B. Dobson and D. N. Harrison.

"On the Capture of Electrons by Swiftly-Moving Electrified Particles." By L. H. Thomas.

UNIVERSITY OF LONDON.

(At University College, Gower Street.)

Monday, February 7, at 5 p.m.—"Reproduction." First of a course of six public Lectures by Dr. A. S. Parkes. February 7, 14, 21, 28, March 7 and 14.

Tuesday, February 8, at 5.30 p.m.—"The Archæology of Great Britain, its Present and its Future." First of a course of four public lectures by Mr. R. E. Mortimer Wheeler, M.A., D.Lit., F.S.A., Keeper and Secretary of the London Museum. February 8, 15, 22, and March 1. (Lantern Illustrations.) Chairman at the first lecture, Professor Ernest A. Gardner.

Tuesday, February 8, at 8.15 p.m.—"Some London Place Names." First of a course of five public Lectures by Miss E. Jeffries Davis. February 8, 15, 22, March 1 and 8. (This course is a repetition of the one given in November, 1926.)

Wednesday, February 9, at 5 p.m.—"The Action of the Sense Organs." First of a course of three public Lectures by Mr. E. D. Adrian, M.D., F.R.C.P., F.R.S., February 9, 16, and 23.

Wednesday, February 9, at 5.30 p.m.—"International Law and Theories of the State." A public lecture by Professor J. L. Brierly, O.B.E., of the University of Oxford.

Wednesday, February 9, at 5.30 p.m.—"Denmark's Greatest Thinker, Sören Kierkegaard." First of a course of six public Lectures by Professor J. G. Robertson. February 9, 16, March 2, 9, and 16.

Thursday, February 10, at 5.30 p.m.—"Americans and American Universities." A public Lecture by Dr. Charles Sisson.

ROYAL SOCIETY OF ARTS.

Wednesday, February 9, at 8 p.m.—(Ordinary Meeting.) Edward Frankland Armstrong, D.Sc., LL.D., Ph.D., F.R.S., Managing Director, British Dyestuffs Corporation, Ltd. : "The Romance of the Organic Chemical Industry."

Friday, February 11, at 4.30 p.m.—(Indian Meeting.) Sir E. Denison Ross, C.I.E., Ph.D., Director, School of Oriental Studies, London Institution, and Professor of Persian in the University of London : "The Arabic History of Gujarat." (Sir George Birdwood Memorial Lecture.) Sir William Foster, C.I.E., will preside.

INSTITUTION OF ELECTRICAL ENGINEERS.

Annual Dinner at the Hotel Cecil, Strand, London, on Tuesday, February 8, at 7.45.

Wireless Section.—Monday, February 7, at 7 p.m.—"Some Interesting Features in Modern Installation Work." To be opened by Mr. R. Grierson.

N. Midland Centre, Hotel Metropole, Leeds.—Tuesday, February 8, at 7 p.m.—Discussion : "Electric Heating and Cooking."

North-Eastern Centre, Armstrong College, Newcastle-on-Tyne.—Tuesday, February 8.—Annual Dinner at the Central Station Hotel, at 7 p.m.

North-Western Centre, 17, Albert Square, Manchester. Tuesday, February 8, at 7 p.m.—"Electrical Equipment of Track on the Underground Railways of London." By A. R. Cooper.

ROYAL INSTITUTION.

Monday, February 7, at 5 p.m.—General Meeting.

Tuesday, February 8, at 5.15 p.m.—"Animal Growth and Development," By Professor Julian Huxley.

Thursday, February 10, at 5.15 p.m.—"Acoustical Problems—Echoes." By Sir William Bragg.

Friday, February 11, at 9 p.m.—Ernest Law, C.B., Author of "History of Hampton Court," etc. : "Old Hampton Court Palace Revealed."

Saturday, February 12, at 3 p.m.—"'Atmosphere' in Fiction." By Walter de la Mare.

THE INSTITUTE OF METALS.

At the Annual General Meeting of the Institute of Metals, to be held in London on March 9 and 10, seventeen papers are expected to be submitted. In the evening of March 9, the annual dinner of the Institute will take place at the Trocadero Restaurant. Following the dinner—at which there will be a curtailed toast list—a dance will be held. This dinner dance is the first function of the kind to be arranged by the Institute.

The annual autumn meeting of the Institute of Metals will be held at Derby in September. Arrangements for the meeting are being made under the direction of Sir Hanry Fowler, K.B.E., LL.D., of Derby. Sir Henry, who is Chief Mechanical Engineer of the London, Midland and Scottish Railway Company, has just been appointed a Vice-President of the Institute.

The past year witnessed a steady growth in the membership of the Institute of Metals in spite of Great Britain's industrial troubles. The membership on December 31, 1926, was 1,801, as compared with 1,602 a year previously. If this rate of increase is but slightly raised during 1927 the membership should reach the 2,000 mark before the Institute celebrates its 20th anniversary next year. The next election to membership is due to take place on January 19, followed by another on February 23. Particulars of the Institute, incorporated in a newly-issued booklet, can be obtained by intending applicants for membership from the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

895.—Aluminium Co., of America.—Production of sodium aluminate. January 11th.

1,211.—Auchinachie, P. P. J.—Manufacture of ammonia. January 14th.

960.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of grey to black dyestuffs. January 12th.

961.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of alkyl-pyrazolanthrones. January 12th.

1,164.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of phosphorus oxides. January 14th.

Specifications Published.

263,898.—Wylam, B, Harris, J. E. G., Thomas, J., and Scottish Dyes, Ltd.—Preparation of dyes, colouring-matters, and the like.

263,922.—Haynes, P.E.—Manufacture of carbon dioxide.

264,050.—Barbet, E. A.—Method for the production of dehydrated alcohol.

262,080.—Medicinal preparations.—Rath, C., 42, Ivalidenstrasse, Berlin.

Vaccines and immunizing and like serums; bacteria, cultivating; medicines for internal use.—Chemical substances capable of influencing the causative micro-organisms o fdisease, as described in the parent Specification, are caused to act in vitro on cultures of spiro-chaetae, trypanosomes, cocci, or the like instead of being injected into an animal in conjunction with the micro-organisms. Cultures may be treated with the chemicals or the organisms may be grown on media containing the chemicals. The treated organisms become non-virulent and if necessary may be further weakened by other means such as heating. The preparations may be used directly for immunising or curative treatment, or may be injected into an animal, either alone or in combination with chemicals of the kind described or with other attenuated or virulent cultures, for the production of immunising materials which are recovered

from the organs or blood of the animal. In addition to the chemical substances referred to in the parent Specification, the use of substances having structural or biological relationship with albumen or its fission products, or capable of developing substances having these properties in the animal organism, is referred to in connection with the present invention and with that of the parent Specification.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ZELOSO.

475,595.—All goods in Class 1, which includes chemical substances prepared for use in medicine and pharmacy. —Goodlass Wall and C., Ltd., 42 and 44, Seel Street, Liverpool. January 19th.

SE-RUK.

475,036.—Chemical substances prepared for use in medicine and pharmacy.—John Blackbourn, John Richard Blackbourn, and George Edward Blackbourn, trading in co-partnership, 53, Auckland Road, Doncaster. January 19th.

STEPHEN JAMES RALPH

on the death of his Mother, Bithiah Ralph, of Balham, became entitled to her Estate. Information as to his whereabouts after 1920 is required by the Administrator, The Public Trustee, Kingsway, London.

FRENCHMAN is prepared to give Lessons in French Grammar and Conversation.—Write, " C," c/o *Chemical News*.

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THE STRUCTURE OF NICKEL.

By HAWKSWORTH COLLINS, B.A., (Camb.)

The constitution of an atom of nickel has previously been given in the *Chemical News*, 1920, CXXI., 184, with reasons as SiP.

This will now be proved to be correct quite independently by means of the laws of relative volume and of heat of formation, *i.e.*, by means of two absolutely independent series of experimental data, *viz.*, S.G., and H.F., neither of which came into the former proof.

TABLE I.

THE RELATIVE VOLUMES OF NICKEL.

(1)	Ni(59)	=	Si(28)	+	P(31)
(2)	7.13	=	7.13	+	0
(3)	11.53	=	11.53	+	0
(4)	5.02	=	5.02	+	0
(5)	14.56	=	0	+	14.56
(6)	19.58	=	5.02	+	14.56
(7)	8.065				
(8)	6.64				
(9)	6.925				

TABLE II.

EXPERIMENTAL DATA ILLUSTRATING TABLE I.

	Relative Volume.	Theor. S.G. at 15° C.	Obs. S.G.	
(10)	Ni 7.13	8.275	8.279	Richter
(11)	NiS 7.13 + 10.51	5.16	4.601	Kenngott
			5.65	Rammelsberg
(12)	Ni_2S 2(7.13) + 10.51	6.055	6.05	Playfair & J.
(13)	Ni_4S_5 4(7.13) + 5(10.51)	4.88	4.81	19° Dana
(14)	Ni_5S_7 5(7.13) + 7(10.51)	4.75	4.7	Liebe
(15)	NiAs 7.13 + 11.38	7.24	7.39	16° Ebelmen
			7.134	Genth
(16)	$NiAs_2$ 7.13 + 2(11.38)	6.99	6.9	McCay
			7.099	Breithaupt
(17)	Ni_3As 3(7.13) + 11.38	7.7	7.71	Descamps
(18)	NiSAs 7.13 + 10.51 + 11.38	5.72	5.65	Forbes
			6.1977	Sipocz
(20)	$NiF_2.3H_2O$ 7.13 + 20.72 + 5.42 + 3(14.03)	2.01	2.014	19° Clarke
(21)	$NiPtBr_6.6H_2O$ 7.13 + 19.58 + 23.09 + 5(18.07) + 6(14.03)	3.75	3.715	Topsoe
(22)	$NiPtI_6.6H_2O$ 7.13 + 19.58 + 32.77 + 5(27.75) + 6(14.03)	3.976	3.976	Topsoe

(23)	$Ni_3(AsO_4)_2$ 3(7.13) + 2(34.64)	5.02	4.982	Bergmann
(24)	$Ni(C_2H_3O_2)_2.4H_2O$ 7.13 + 2(40.22) + 4(14.03)	1.733	1.734	Schroder
(25)	$Ni_3(CO_3)(OH)_4.4H_2O$ 3(7.13) + 8 7.53 + 2(2.51) + 4(2.51 + 5.76) + 4(14.03)	2.57	2.57	Silliman
(26)	Ni_2O_3 2(11.53) + 2(4.45) + 2.51	4.814	4.814	Playfair & J.
(27)	$Ni_2P_2O_7$ 2(11.53) + 2(14.56) + 2(4.45) + 5(2.51)	3.96	3.9309	25° Nostrand *i.e.*, 3.95 15°
(28)	$NiSO_4$ 11.53 + 30.59	3.68	3.652 - 3.696	Schroder
(29)	$NiSO_4.7H_2O$ 11.53 + 35.61 + 7(14.03)	1.933	1.931	Schiff
(30)	$NiK_2(SeO_4)_2.6H_2O$ 11.53 + 2(18.05) + 2(36.35) + 6(14.03)	2.587	2.587	17° Petterssen
(31)	$NiTl_2(SeO_4)_2.6H_2O$ 11.53 + 2(21.77) 2(36.35) + 6(14.03)	4.053	4.066	13.°3 Petterssen
(32)	NiP_2 5.02 + 2(10.51)	4.65	4.62	18°/4 Interntl.
(33)	NiP_3 5.02 + 3(10.51)	4.16	4.19	18°/4 Inte.ntl.
(34)	$NiBr_2$ 5.02 + 23.09 + 18.06	4.74	4.64	28°/28 Nostrand *i.e.* 4.7 15°
(35)	$Ni(NO_3)_2.6H_2O$ 5.02 + 2(26.39) + 6(14.03)	2.05	2.037	22° Laws
			2.065	14° Laws
(36)	$Ni(ClO_3)_2.6H_2O$ 5.02 + 2(23.01) + 2(7.53) + 4(2.51) + 6(14.03)	2.08	2.07	International
(37)	$Ni(ClO_4)_2.7H_2O$ 5.02 + 2(23.01) + 2(7.53) + 6(2.51) + 7(14.03)	2.14	1.15	International
(38)	NiSe 5.02 + 11.31	8.4	8.462	Little
(39)	$NiCl_2$ 5.02 + 2(23.01)	2.55	2.56	Schiff
(40)	Ni_2S 5.02 + 11.53 + 10.51	5.543	5.52	Nostrand
(41)	Ni_3P_2 3(5.02) + 10.51 + 14.56	5.956	5.99	Nostrand
(42)	$NiSO_4$ 14.56 + 30.59	3.44	3.418	15° Thorpe
(43)	$NiSO_4.6H_2O$ 14.56 + 30.59 + 6(14.03)	2.034	2.031	15° Thorpe
(44)	$NiSO_4.7H_2O$ 14.56 + 30.59 + z 7(14.03)	1.961	1.98	Nostrand
(45)	$K_2Ni(SO_4)_2$ 2(18.05) + 14.56 + 2(30.59)	2.94	2.897	Playfair & J.
			3.086	Schroder
(46)	$K_2Ni(SO_4)_2.6H_2O$ 2(22.29) + 14.56 + 2(30.59)+ 6(14.03)	2.137	2.136	Kopp
(47)	$Am_2Ni(SO_4)_2.6H_2O$ 2(23.87) + + 14.56 + 2(30.59) + 6(14.03)	1.90	1.783 - 1.921	Kopp
(48)	$NiPdCl_6.6H_2O$ 14.56 + 9.05 + 23.01 + 5(15.085) + 6(14.03)	2.35	2.353	Topsoe
(49)	$NiPtI_6.9H_2O$ 14.56 + 19.58 + 32.77 + 5(27.75) + 9(14.03)	3.546	3.549	Topsoe
(50)	$NiBr_2.6NH_3$ 19.58 + 2(23.09) + 6(18.11)	1.84	1.837	Topsoe
(51)	$NiI_2.6NH_3$ 19.58 + 2(35.55) + 6(18.11)	2.08	2.101	Nostrand
(42)	$K_2SeO_4.NiSO_4.6H_2O$ 2(18.05) + 36.35 + 19.58 + 30.59 + 6(14.03)	2.34	2.34	Gerichten
(53)	$NiAm_2Cl_4.6H_2O$ 19.58 + 2(23.87) + 4(15.085) + 6(14.03)	1.63	1.645	Nostrand
(54)	NiO 8.065 + 4.45	6.0	5.597	Playfair & J.
			6.398	Bergemann
(55)	$NiWO_4$ 8.065 + 21.59 + 7.53 + + 3(2.51)	6.86	6.85	22° Davis

(56)	Ni_4S_5 4(8.065) + 5(10.51)	4.67	4.54 - 4.81	Dana
(57)	NiF_2 8.065 + 20.72 + 5.42	2,836	2.855	14° Clarke
(58)	$NiSO_4$ 8.065 + 35.61	3.55	3.526	Playfair
			3.643	16° Pape
(59)	Ni 6.64	8.88	8.88	Arndtsen
(60)	Ni_5P 2(7.13) + 3(6.64) + 10.51	7.29	7.283	Jannetaz
(61)	NiS 6.64 + 10.51	5.306	4.601	Kenngott
			5.65	Rammelsberg
(62)	Al_6Ni 6(9.05) + 6.64	3.627	3.647	Michel
(63)	Ni 6.925	8.52	8.477 - 8.713	Baumgartner

TABLE III.

HEAT OF FORMATION OF NICKEL.

		Orig. Vol.	Rel. Vol. in combination at 15° C.	Change of Volume
(64)	- 34590 = 120 × (-4.89) × 59	6.64	= 11.53	- 4.89
(65)	aq. - 34040			
(66)	- 10040 = 120 × (-1.425) × 59	6.64	= 8.065	- 1.425
(67)	-8065 = 120 × (-1.14) × 59	6.925	= 8.065	- 1.14
(68)	0 = 120 × 0 × 59	6.64	= 6.64	- 0

TABLE IV.

RELATIONS BETWEEN H.F. IN LARGE CALORIES AND REL. VOL.

$$34.590 = 3 \times 11.53$$
$$10.040 = 2 \times 5.02$$
$$8.065 = 1 \times 8.065$$

Several examples of this peculiarity, which evidently has a deep-seated reason, have been given in previous papers.

TABLE V.

EXPERIMENTAL DATA ILLUSTRATING TABLE III.

	Heat of Formation.		Theor.	Obs.	
(69)	Ni. Se - 34590 + 46380	=	11790	14900 pp.	9900 cryst.
(70)	Ni. Te - 34590 + 46130	=	11540	11600	
(71)	Cd. Se - 31000 + 46380	=	15380	14300	
(72)	Cd. Te - 31000 + 46130	=	15130	16600	
(73)	Ni. F_2 - 34590 + 2(76820)	=	119050	118980	
(74)	Ni.O.H_2O - 34590 + 96155 + 0 (corresponds with No. 26.)	=	61565	60840	
(75)	H_2.O - 2(24350) + 117460	=	68760	68360	Thomsen
				69000	Berthelot
(76)	Ni.O_2.H_2 - 34590 + 96155 + 117460 - 2(24350)	=	130325		
(77)	aq.Ni.Cl_2 - 34040 + 2(63870)	=	93700	93700	
(78)	aq.Ni.Br_2 - 24040 + 2(52930)	=	71820	71820	
(79)	aq.Ni.I_2 - 34040 + 2(37720)	=	41400	41400	
(80)	aq.Ni.O_2.SO_2 - 34040 + 2(96155) + 0	=	158270	158280	
(81)	S.O_2 6217 + 2(32341)	=	70899	71080	Thomsen
(82)	aq.Ni.O.SO_3 - 34040 + 96155 + (96155 - 71515)	=	86755	86950	
(83)	aq.S.O_3 6217 + 2(32341) + 71515	=	142144	142410	Thomsen
(84)	aq.Ni.O_2.N_2O_4 - 34040 + 2(32341) + 85332	=	115974	115890	

(85)	aq.$Ni.O.N_2O_5$ - 34040 + 32341 + 85332	=	83633	83420	
(86)	aq.$Ni.F_2$ - 34040 + 2(77500)	=	120960	120800	
(87)	aq.$Ni.N_2.O_6$ - 34040 - 2(23300) + 6(32341)	=	113406	113240	
(88)	$Ni_2.O_3.3H_2O$ - 2(8065) + 2(32341) + 71515 - 3(0)	=	120067	120380	
(89)	$Ni.O_2.SO_2.7H'_2O$ - 8065 + 2(96155) 0 - 7(3205)	=	161810	162530	

(corresponds with No. 58.)

(90)	$Ni.N_2.O_6.6H'O_2$ - 8065 - 2(23300) + 6(32341) - 6(3205)	=	120151	120710	
(91)	$Ni.O_2.N_2O_4.6H'_2O$ - 8965 + 2(32341) + 85332 - 6(3205)	=	122719	123360	
(92)	Ni.S 0 + 19277	=	19277	19500	
(93)	$Ni.S.xH'_2O$ 0 + 19277 - 3205	=	16072	17390	

The last two correspond with No. 61, the S-atom being formed from crystaliised sulphur of S.G. 2.0605 and volume 15.53. This vol. descends to 10.51, so that the change is 5.02; and 19277 = 120 × 5.02 × 32.

(94)	$Ni.Cl_2.6H'_2O$ 0 + 2(56786) - 6(3205)	=	*94342*	*94860*	
(95)	Ni.O - 10040 + 71515	=	61475	61500	

(corresponds with No. 54.)

(96)	aq.H.Cl - 24350 + 63870	=	39520	39315	T
(97)	aq.$H_2.S.O_4.H'_2O$ - 2(24350) + 6217 + 2(32341) + 2(96155) - 3205	=	211304	210770	T
(98)	aq.$Ni.S.O_4$ - 34040 + 6217 + 2(32341) + 2(96155)	=	229169		

This follows from Nos. 80—83.

Heat of Neutralisation.

When (76) and (97) produce (98) and 3 times (75),

96155 becomes 117460
- 34590 becomes - 34040
- 3205 becomes 0

(99) 117460 - 96155 - 34040 + 34590 + 3205 = 25060 26110 T

Heat of Solution of $NiCl_2.6H_2O$.

When (94) produces (77) and 6 times (75),

0 becomes - 34040
2(56786) becomes 2(63870)
- 6(3205) becomes 0

(100) - 34040 + 2(63870) - 2(56786) + 6(3205) = - 642 - 1160 T

Heat of Solution of Metal.

When Ni and twice (96) produce (77) and H_2

0 becomes - 34040
- 2(24350) becomes 0

(101) 2(24350) - 34040 = 14660 16190 T

Heat of Neutralisation.

When (76) and twice (96) produce (77) and twice (75)

96155 becomes 117460
- 34590 becomes - 34040

(102) 117460 - 96155 - 34040 + 34590 = 21855 22580 T

The volume 7.13 is correct for 18 independent reasons;

(A1) It satisfies the law of relative volume
(A2-A18) There are 17 substances in Table II. which give this vol.
11.53 is correct for 9 independent reasons;
(B1) It satisfies the law of rel. vol.
(B2-B7) 6 substances in Table II give this vol.
(B8) It gives a value of H.F. in Table III. which is shown to be correct in **7** cases in Table V. *et seq*.
(B9) It comes into Table IV.

Similarly, 5.02 is correct for 12 reasons, 14.56 for 9, 19.58 for 4, 8.065 for 8, 6.4 for 8, and 6.925 for 2.

SUMMARY.

More than 100 experimental data are here arranged in such a manner as to demonstrate the structure of an atom of nickel. No hypothesis is introduced. The deductions are very definite discoveries, not guesses.

The proof that this structure is correct consists in the facts :—

(C1) That 5 out of 8 rel. vols. can be split up into parts which have previously been demonstrated to be vols. of Si or P, either of which may be absorbed by the other.

(C2) Four of the vols. produce the correct values of H.F. in accordance with the law.

(C3) The intricate interdependence of facts is exactly similar to that with regard to the 28 other elements already published

In addition to demonstrating the structure of Ni, this paper accomplishes several other objects. It strengthens

(D1) The law of relative volume, and

(D2) The law of heat of formation;

(D3) It continues the reduction of the facts of S.G. to exact instruments of research.

(D4) It continues the demonstration that although the total volume of H_2O as water of crystallisation is less than its volume as liquid water, heat is absorbed in passing from the liquid to the crystal state. There are numerous instances of water of cryst. (14.03) in Table II., the vol. of liq. water at 15° C. being 18.02. There are 5 examples in Table V. of the liquid molecule absorbing 3205 calories in becoming crystalline.

(D5) The paper demonstrates the reasons for Thomsen's experimental effects, but not necessarily of his calculated effects, because it is evident that results can only be calculated on the assumption that there is absolute uniformity in the formation of molecules, *i.e.*, that the volumes of the elements never vary.

The matter in this paper cannot be adequately appreciated without a study of all previous papers, since many things ought to be mentioned for which there is no room. *E.g.*, in molecules which have several atoms of one element, it is quite common for one of them to have a different volume from the others, as in Nos. 48, 49, etc. Also whenever a group of elements (*e.g.*, NH_3 in No. 50) is given as a single volume, the parts have been given before. In this case 18.11 = 0.83 + 3(5.76).

The intricate interdependence of experimental data contained herein is more fundamentally implied by the words " corresponds with No X " in Table V. than in any other part of the paper; but there is no room here to demonstrate this. Reference can only be made to similar cases fully demonstrated in the papers on arsenic and manganese.

NOTE ON SOME PROPERTIES OF COMPLEX SALTS OF LEAD IODIDE, AND ALKALI HALIDES.

By LESLIE JAMES BURRAGE.

The following systems were investigated with a view to establishing the exact number of compounds which exist, and their composition (*J. Chem. Soc.*, 1926, p. 1703).

(1) $PbCl_2$ - KCl - H_2O
(2) $PbBr_2$ - KBr - H_2O
(3) PbI_2 - KI - H_2O

Five compounds were isolated at 25°.

(1) $KCl.2PbCl_2$ and $KCl.PbCl_2.\frac{1}{3}H_2O$
(2) $KBr.2PbBr_2$ and $KBr.PbBr_2.\frac{1}{3}H_2O$.
(3) $KI.PbI_2.2H_2O$

It has been noted by Heise (*J. Phys. Soc.*, 1912, XVI., 373), that lead chloride, bromide and iodide combine with pyridine and give long needles which rapidly lose pyridine in air.

In this connection an interesting property has been discovered of the lead iodide complex salt, $KI.PbI_2.2H_2O$, which is not shared by similar double salts containing chlorine and bromine—its great solubility in acetone; $KI.PbI_2.2H_2O$ dissolves in acetone to the extent of 809.1 gms salt per 1,000 gms. acetone. This acetone solution

is bright yellow in colour. Experiments showed that the following double salts also exist — $PbI_2.NH_4I.2H_2O$ and $PbI_2.NaI.2H_2O$. Both these are similar in appearance to the potassium compound and they also dissolve in acetone to give bright yellow solutions. An aqueous solution also has a yellow colour due to the formation of complex ions, in this case most probably the ion PbI_3'.

If ether is added to this acetone solution about eighty per cent. of the dissolved salt separates out as an oily yellow substance which coagulates and forms a flocculent precipitate. This was washed with ether and dried in this manner without warming. The resulting pale yellow solid deepened considerably in colour on standing over calcium chloride. The original compound undergoes the same change when treated in a similar manner. This is presumably due to the substance losing part of its water of crystallisation.

Some of this dried compound was heated. It melted at about 300° C., giving rise to a deep purple fusion and, on allowing this to cool, it set to a pale yellow mass, the needle-shaped crystals being quite apparent. This was repeated several times and the resulting solid treated with acetone. As in the previous case, the substance dissolved to give a yellow solution. The solid obtained after cooling the melt gave no coloration with starch showing that no iodine had been liberated.

The author desires to thank Professor Allmand, under whose direction the work was carried out.

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General Notes.

NEW DEPARTMENT AT THE MELLON INSTITUTE, PITTSBURGH.

The director of the Mellon Institute, Dr. Edward R. Weidlein, according to *Chemicals*, states that there has been established in the Institute a definate department of research in pure chemistry, with Dr. Leonard H. Cretcher (A. B., Michigan, 1912; Ph.D., Yale, 1916) has been in charge of the Institution's fundamental chemical studies since 1922, and has published jointly with several assistants and other members of the Institute a number of papers on the results of their organo-chemical researches.

MOTH RESISTANCE PROBLEMS.

Chemicals reports that the discovery of a dyed-felt at the Jefferson Quarter-master Intermediate Depot which resisted the attacks of moths, led the Quarter-master General of the Army to hold a conference with representatives of the Bureau of Standards, Department of the Navy, and Agriculture, as well as those from chemical and dye concerns, with a view of determining whether certain dyes or colours render textiles immune to moths, the Department has just announced.

A conference which may result in interesting developments was held on Friday, January 7th in the Office of the Quartermaster General of the Army at which there were present representatives from the Bureau of Standards, the Department of Agriculture, the Navy Department and from chemical and dye concerns.

If it can be determined that certain dyes or colours render textiles immune to attacks by moths, it will result in enormous savings, not only to the Army but to the entire textile industry and may have a marked effect upon the future colour of all woollen textiles used by the Army.

SCRAP IRON AND STEEL FROM FRANCE.

Details have previously been given of the arrangements made with the French Government regarding the distribution among United Kingdom importers of the contingent of scrap metal allowed to be exported from France to this country during the year 1926. Similar arrangements hold good for 1927, 30,000 metric tons allocated to Great Britain and Northern Ireland being available.

INDIA STORES DEPARTMENT: OILS AND LUBRICANTS SPECIFICATIONS.

H.M. Trade Commissioner at Calcutta has forwarded a pamphlet, relating to specifications regarding oils and lubricants, as issued by the Chief Controller of Stores, India Stores Department, Delhi. It is suggested that by the following the instructions contained therein British manufacturers should be able to avoid delay and misunderstanding in the supply of suitable materials as required by the India Stores Department.

British firms interested may consult the pamphlet referred to on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

NEW MINING EXAMINATION RULES.

The Mines Department announce that new Rules governing the qualifications and examinations of applicants for First and Second Class Certificates of Competency as Managers and Under-Managers of Mines have been adopted by the Board for Mining Examinations, and will come into force on March 1, 1927.

Modifications have been made in the character of the practical experience in mining required of applicants for Certificates, and also in the maximum marks for the oral examinations.

Copies of the Rules, entitled the "Mining Examinations (Qualifications for Certificates of Competency) Rules, 1926," will shortly be placed on sale, and may be purchased from H.M. Stationery Office either directly or through the usual agents.

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon, February 7, Sir Arthur Keith, Treasurer and Vice-President, in the chair.

The thanks of the Members were returned to Dr. T. W. Dewar for his donation of £9 9s. to the Research Fund.

Mr. J. L. Callow, Mr. C. V. H. Garnett, Sir Richard Gregory, Mr. J. E. Joseph, Mr. M. H. Kilgour, Sir Henry Miers, Sir Joseph Petavel, Miss E. M. G. Swann, Miss K. Thomas, Mr. C. J. Ussher, and Miss A. H. Wilson were elected Members.

FRENCH MATCH MONOPOLY.

The British Ambassador at Paris reports that, according to reports recently published in the local press, the competent department of the French Ministry of Finance has drafted a proposed convention for farming out the matches monopoly, which is shortly to be submitted to the Cabinet, and will then be laid before Parliament in the form of a Government Bill. It is stated that under the proposed convention the monopoly would be conceded to a French company, in which the majority of the capital would be French, and in which foreign participation might in no case exceed 35 per cent. of the capital. The Board would be composed exclusively of French directors, with the exception of one member, who would represent a Scandinavian group, which it is understood has already promised its support.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on January 2, 1927 :—

Adhesives and Adhesions : True Chemical Compounds as Adhesives. By J. W. McBain, F.R.S., and W. B. Lee.

Pure crystalline substances fully rival well-known adhesives in the strength of joint obtainable by them and may yield joints between optically polished metal surfaces whose breaking strength may approach one ton per square inch. Pure liquids give results of a lower order of magnitude, even when they are only a few millionths of an inch thick. In all cases the thinner the film, the stronger the joint. This rule holds for ordinary adhesives as well, provided that the film completely fills the space between the surfaces joined. There is direct parallelism between joint strength and the mechanical properties of the materials joined. Joint strength rises with tensile strength and elasticity, and falls with atomic volume and compressibility. Good lubricants with high spreading coecients are poor adhesives. Joint strength is often much the same, whether tested in tension or in shear. Disorderly arrangement greatly enhances strength and joint strength.

The Structure of Phenacite, Be_2SiO_4. By W. L. Bragg, F.R.S.

The structure of phenacite, Be_2SiO_4, was examined, and an attempt made to find positions of silicon and oxygen atoms. The structure proposed shows a novel type of arrangement. It resembles the simpler structure of the olivine group (Mg_2SiO_4, Fe_2SiO_4) in that its form may be explained as a packing together of oxygen atoms whose centres are 2.7 A apart, with the atoms of metal and silicon between groups of oxygen atoms, but the arrangement is more complex.

In Mg_2SiO_4 these atoms are nearly in positions of hexagonal close-packed assemblage, magnesium atoms being placed between six oxygen atoms and silicon atoms between four oxygen atoms. In phenacite, silicon atoms lie at centre of tetrahedral groups, and similar positions are probably occupied by beryllium atoms. A re-arrangement is achieved at expense of slight increase in volume associated with each oxygen atom, when the structure is con-

trasted with such structures as $BeAl_2O_4$, where close-packing holds.

The structure is determined by 21 parameters, 15 of which are measured. These parameters fix the silicon and oxygen atoms alone. A solution involving so many parameters needs careful checking, but it is believed that the method adopted of using absolute measurements leads to a close approximation to true structure.

The Physical Interpretation of the Quantum Dynamics. By P. A. M. DIRAC. Communicated by N. Bohr, For.Mem.R.S.

To interpret physically calculations of quantum dynamics, a number of special assumptions are previously made — *e.g.*, that the elements of the matrix that represents the total polarisation determine the frequencies and intensities of the spectral lines, in analogy with the classical theory, or that the square of the amplitude of Schrödinger's wave-function determines a probability.

In the paper a general method is given for obtaining physical results from a mechanics that uses non-commutative multiplication. For a system with a single degree of freedom it is shown that if a numerical value is specified for any constant of integration ξ, and if y is the variable canonically conjugate to ξ, we can determine without ambiguity the size of the range of y for which any constant of integration lies between any two specified numerical values (*e.g.*, if it is given that the system is in the state $J = nh$, we can determine the size of the range of w for which the co-ordinate q at a specified time has a value lying between two specified numerical values).

The theory for any number of degrees of freedom is worked out. The results obtained in this way appear to be the most general that can be got from quantum dynamics, and probably all the information that the physicist requires. It is shown that the theory is in agreement with the special assumptions previously used.

For the mathematical investigation a general transformation theory of matrices of matrix mechanics is required, which is here worked out. Schrödinger's wave-equation finds a very natural place in this theory.

THE INSTITUTION OF MINING AND METALLURGY.

The third Ordinary General Meeting of the thirty-sixth session was held on Thursday, December 16, 1926, at the Rooms of the Geological Society, Burlington House, London, Sir Thomas H. Holland, President, in the chair.

The President said that before beginning the business of the meeting the Council wished him to make a preliminary announcement of the programme they had in view, so that the members, more especially those who were away, might be ready to take part in the proposed discussion.

Some of the members might have been patient enough to read a part of the Address which he (the President) gave to the Royal Society of Arts, in November, regarding the international aspects of raw materials. In dealing with mineral questions, he had had to refer to a feature which concerned the Institution of Mining and Metallurgy, as there was no other Institution in this country which was in the same position of responsibility regarding the problem.

Some of them had been feeling that whilst the members had been doing excellent work in dealing with specific problems connected with the local occurrences of minerals, with mininm methods and with metallurgical processes, the Institution had now attained an age and an importance which justified it in making its position felt in public questions.

He supposed that everybody know how the question of Free Trade *versus* Protection passed from the region of straightforward economics into one of political party warfare, and had consequently become so debased that no one could introduce either economics or commonsense into the problem for years after. Gradually, however, the Empire had begun again to realise that it was up against facts. They were anxious as an Institution that such questions as State *versus* private ownership of mineral rights should not become a political question, but should be retained by those who were best able to judge of the merits of the proposition which lay between the two extremes.

The Council proposed to have a discussion during the month of March on certain resolutions which would be drafted during the session. It was suggested that at the March Meeting the discussion should be opener by a general paper dealing with the

international aspects of minerals, and that might be followed by a paper pointing out the meaning of statistics of production, distribution, and consumption; and by another paper dealing with the question of mineral law; with possibly a paper or two on specific minerals treated by one or two specialists, showing in what way, within the Empire, we were self-contained with regard to particular products, to what extent we had stocks to spare, and to what extent we ought to advise our Governments to control the export, import, and development of those minerals.

Those who remembered the remarkably interesting Address which Mr. Frank Merricks had given to the Institution in 1920 would remember that he dealt with the Empire as a whole, and confined himself necessarily, because of the shortness of time, to the principal minerals. But the problem before them now was something more precise. There were certain accessory minerals which did not show in the Blue Book returns, but they were nevertheless necessary for the maintenance of the industries of the country and might become of vital importance in time of isolation on account of war. For that reason, too, they wanted to deal with the Dominions and the Colonies as separate units, for they were so separated geographically that in time of war any one or two, or any group, might be cut off from the rest. One had to remember that Great Britain was the principal manufacturing centre of the Empire and also the principal ordnance base, so that the isolation of any of the Dominions from Great Britain might at any time become serious, apart altogether from the question to which he had referred just now, the economic question of facilitating movements within the Empire and, if necessary, of building a defensive wall around it.

Mr. Merricks had dealt with many of the aspects of the question. With regard to the development of raw materials and the organisation in war departments for the development of raw materials and Dominion resources, Mr. Merricks ponited out that mining and metallurgical specialists ought to be associated with those departments, and had felt constrained to promise that the Institution of Mining and Metallurgy would gladly lend itself to assist Government organisations in that way.

If they passed the resolutions which they contemplated, and sent them to the Empire Congress in Canada in 1927, they would represent the general feeling of the Institution here with regard to metalliferous minerals as well as metallurgy, because the question of smelting was quite as important as the question of mineral resources. It was proposed that the discussion opened in March should be concluded in May, and deal with the proposed resolutions for the Congress at Montreal in August.

The April meeting would be devoted to the annual business of the Institution and the Presidential Address of his successor.

There was one point he ought to refer to, and that was the limitations of their sphere. He assumed that they need not, and could not under their Constitution, deal with coal, and they need not deal with the question of petroleum, because that was being taken up in exactly the same way by the Institution of Petroleum Technologists. With regard to mineral statistics, there was a Mineral Bureau at the Imperial Institute, which had been doing excellent work in getting together and distributing figures, but no mineral statistics could answer the numbers of questions which they wished to get answers, and which the Government must be in a position to face. They told them nothing about the future of the mineral industry, and nothing about the extent of their resources. A large output of minerals might mean the development of large resources, or it might mean the early exhaustion of them. The statistics told them nothing whatever about those minerals which could be developed at a time of high prices or of necessity, and which were not now developed during times of low or even normal prices, and consequently did not appear in annual output statistics.

THE PHYSICAL SOCIETY OF LONDON.

At the Meeting held on Friday, December 10, 1926, at the Imperial College of Science, Prof. O. W. Richardson, M.A., D.Sc., F.R.S., in the chair, the President announced that, by a unanimous resolution, the Council had awarded the Duddell Medal for 1927 to Mr. F. Twyman, F.R.S.

The following paper was read :—

"*A Capacitance Bridge of Wide Range and a New Inductometer.*" By ALBERT CAMPBELL, M.A.

ABSTRACT.

A bridge is described by which quick measurements can be made of capacitances covering a range of from $1\mu\mu F$ up to $30\mu F$,

the power factor also being indicated. The unknown capacitance C is put in parallel with a resistance P, and the effective self-inductance of the combination, which is approximately equal to $+P^2C$, is read on a mutual inductometer forming part of the bridge. By giving P a series of suitable values scale multipliers providing for a very wide range of capacitance are obtained. The inductometer used is of a new type, having a circular scale extending to about 260°, the percentage accuracy of reading being almost constant over the greater part of the range. This novel scale system allows the lower readings to be taken with good accuracy. A small rheostat allows the power loss in the condenser to be balanced, and enables the power factor to be deducted.

DISCUSSION.

Mr. D. W. Dye said that it seemed paradoxical at first sight that a high impedance could be more accurately measured when diluted with a shunt, but, as in a method described by himself in which the impedance to be measured is shunted by a resistance of 100,000 ohms, the dilution had the effect of making an accurate measurement practicable. The new scale of the instrument, which was substantially that of a slide rule, was particularly valuable, and might be applied with advantage to other instruments. Would it be possible to make the inductometer astatic, in order to avoid the errors introduced by variation of the earth capacity of the telephones?

Dr. E. H. Rayner said that the proposed method of measuring power factor was particularly interesting in view of the importance of the power factor in determining the behaviour of cables under high voltages. The volt-amperes applied to an ordinary cable circuit amount to about 200 times the rea lpower, the power factor being nearly 90 degrees, and in measuring this factor a sensitivity of 0.0001 radian at 20,000 volts is desirable.

Mr. Rollo Appleyard said that the instrument would be of great value to electricians if it could be had at a moderate price. The scale was that of the aneroid barometer, and in effect it was the same scale as that originally used by Cavendish when he first compared the capacity of a battery of Leyden jars with that of a small plate condenser by repeated sharing of charges.

Mr. G. W. Sutton asked whether it would be possible to design the instrument so as to avoid the effect of capacity between the primary and secondary of the mutual inductance.

Author's Reply.—In reply to Mr. Dye: The procedure in my method of testing condensers is quite the same as that employed in Mr. Dye's method of testing large self-inductances (which, I may remark, is probably the most accurate of all known methods for that purpose); but the two methods depend on quite different formulæ. Thus, while the condenser method is practically direct reading and independent of frequency, while in the self-inductance method the results have to be deduced by calculation involving the frequency.

With regard to astaticism, it is not very difficult to obtain moderate astatacism in an inductometer of the new type, but I think that astaticism almost always involves loss of efficiency (*e.g.*, by increaseing the weight of wire used). In the present model of the capacitance bridge, I have not found the effect of stray fields troublesome, so long as the generator is kept sufficiently distant. In reply to Mr. Sutton, I would point out that in the capacitance bridge the maximum mutual inductance used is of the order of 50μH, and hence the internal capacitances of the instrument have very little effect. In higher-reading inductometers of the new type the troublesome effects of capacitance are minimised by suitable design of the coils. It is interesting to learn from Mr. Appleyard's remarks that the ordinary aneroid barometer has a scale of constant percentage accuracy; this appears to be due to its inherent law of working, while my inductometer scale is the result of design involving a great number of experiments. I would thank all the speakers for their kind remarks of appreciation.

A Principle Governing the Distribution of Current in Systems of Linear Conductors. By FRANK WENNER, Ph.D., Physical Bureau of Standards. Read by Dr. Alexander Russell, F.R.S., in the absence of the author.

ABSTRACT.

A brief *résumé* is given of the procedures which have been developed for determining the distribution of direct current in systems of linear conductors. In this connection reference is made to practically all the laws, theorems, principles and procedures generally considered to pertain to this particular field of investigation. Consideration is then given to a principle which when employed usually leads more directly to the solution of problems than does any of the procedures commonly used.

This principle applies to systems of linear conductors in which the currents are pro-

portional to the impressed electromotive forces; the electromotive forces may be any function of time and may be distributed in any manner throughout the system; and the branches may contain resistance, inductance, capacitance or any two or all of these in series, may be so arranged as to move with respect to a permanent magnet, thus developing counter electromotive forces, and may be connected by contacts or mutual inductances or both of these. For such a system of conductors the current in any branch is that which would result if all impressed electromotive forces were replaced by a single impressed electromotive force, located in the particular branch and equal to the drop in potential which originally would have appeared across the break had this branch been opened. While this principle is a logical consequence of well-known laws, it has been used by very little and seems to be practically unknown. It is shown here that it may be used to advantage in all or practically all cases in which the conductors form a series-parallel combination or a network which may be changed to a series-parallel combination by opening the branch in which it is desired to determine the current.

A discussion followed.

THE CHEMICAL SOCIETY.

Papers read at the Meeting on Thursday, February 3, 1927.

The Nature of the Alternating Effect in Carbon Chains. Part XIV. The Directive Action of Some Groups of the Form—CR'R".CO.R in Aromatic Substitution. By J. W. BAKER AND C. K. INGOLD.

Ethyl phenylacetate and ethyl phenylmalonate on nitration in nitric acid at or below 0° give respectively 9 per cent., and 20 per cent. of the *m*-derivative. These results are taken to show the occurrence of a permanent fractional dipole in the carbonyl group similar to, but weaker than, the permanent integral dipole present in semi-polar double linkings.

The Nature of the Alternating Effect in Carbon Chains. Part. XVII. The Directive Action of the Groups — $CH_2.CH_2NO_2$, — $CH : CHNO_2$, and — $C(NO_2) : CHR$ in Aromatic Substitution. By J. W. BAKER AND C. K. INGOLD.

α-Nitro-β-phenylethane on nitration yields 13 per cent. of *meta*, whilst with ω-nitrostyrene only 2 per cent. is formed. These results indicate that, in these cases, contrary to the general assumption, the propagation of the effect due to the positive harge on the nitro-group occurs less readily in a conjugated side-chain than in a saturated chain of equal length. It is suggested that this is probably due to the neutralisation of the effect in passing through the field of the double linking, and not to the predominating *op*-orienting influence of the latter, since *p*-nitrobenzylidenephenylnitromethane $PhC(NO_2) : CH.C_6H_4NO_2$ yields 20 per cent. of the *meta*-isomeride on nitration.

The Storch Equation, a General Dilution Formula and the Validity of the law of Mass Action at Limiting Dilutions. By A. FERGUSON AND I. VOGEL.

Graphical methods of testing the Storch dilution formula in its primitive and in a generalised form, and of determining the constants of the equations are described. In all the cases tested the equation in one of its forms is valid over a wide range of concentration. The constants so determined do not support the view that Ostwald's dilution formula is always followed at low concentrations.

The Calculation of the Equivalent Conductivity of Aqueous Solutions of strong Electolytes at Infinite Dilution. Part II. Application to Data at 0°, 18° and 20°. By A. FERGUSON AND I. VOGEL.

A critical review of the methods previously proposed for the calculation of the conductivity at infinite dilution of strong electrolytes is given, and it is concluded that the most trustworthy is that recently suggested by the authors. The method has been applied to data at 0°, 18° and 25°, and new tables of mobilities at these temperatures constructed.

The Calculation of the Equivalent Conductivity of aqueous solutions of strong Electrolytes at Infinite Dilution. Part III. The Mobilities of the Hydrogen and the Hydroxyl Ions. By A. FERGUSON AND I. VOGEL.

The value of the conductivity at infinite dilution for hydrochloric acid at 25°, calculated by the author's method, yields a most probable value for the mobility of the hydrogen ion of 340.05 at 325°. Kraus and Parker's value of 349.89 is criticised. The mobility of the hydroxyl ion at 18° is similarly computed from the conductivity at infinite dilution of sodium hydroxide to

be 175.4. This value differs appreciably from that deduced by Raikes, Yorke, and Ewart, probably on account of their use of the square root formula of Kohlrausch for the computation of the conductivity at infinite dilution.

INSTITUTION OF ELECTRICAL ENGINEERS.

Some Recent Advances in Alternating-Current Measuring Instruments. By LIEUT.-COL. K. EDGCUMBE, R.E. (T.A.), Vice-President, AND F. E. J. OCKENDEN, Graduate.

This paper has been prompted by the large amount of valuable material which been produced during the last few years, but little of which has been brought into such a form as to make it available to the designer of electrical measuring instruments.

By a process of elimination, the operating principles employed are gradually becoming less in number. For example, the use of the hot-wire principle is now almost confined to radio-frequency measurements, and the prophecy is hazarded that for the measurement of current and voltage at ordinary frequencies, the electro-dynamic and induction principles will, before long, give place to the moving-iron principle. A useful feature possessed by the moving-iron type of meter is the wide latitude which is possible as regards the opening out or closing in of the scale divisions to suit the purpose for which it is required.

The moving-iron instrument is investigated, from what is thought to be a new standpoint, and a form of "precision" moving-iron ammeter and voltmeter, with an electrical accuracy of about 0.1 per cent. and suitable for use indiscriminately with alternating current and direct current, is described.

The use of series condensers for the extension of the range of electrostatic voltmeters for extra-high-voltage measurements is dealt with, the conditions necessary for the attainment of reasonable accuracy being considered.

The use and limitations of thermo-expansion (hot-wire) ammeters for radio-frequency current measurements is considered, and a current transformer suitable for such measurements up to 1,000 amperes is described.

It is shown that special considerations are involved in the measurement of rectified current.

Some recent developments in the field of graphic instruments are dealt with, particularly as regards the "relay" pattern which has proved to be valuable for traction and many other special purposes.

A method of ensuring constant frequency on a supply system is considered, together with the advantages which accrue, particularly as regards ease of interlinking, and the possibility of driving recorders, time switches, etc., by means of a simple and compact self-starting synchronous motor.

The design of current transformers is dealt with in detail, including the use of some new materials for the core, permeability and core-loss curves being given. The design of a bar (bushing) curren ttransformer for low currents as wel lof a precision type of current transformer is described. The latter is suitable for use with sub-standard measuring instruments, and has a ratio error of less than 0.1 per cent and a phase displacement of less than 5 minutes. The desirability of connecting a protective resistance in series with voltage-transformer fuses is emphasised, and it is shown that such a resistance, if properly designed, need not adversely affect the characteristics of the transformer.

The capacity of meters, shunts, current transformers, etc., to withstand heavy short-circuits, is considered, and safe limiting values are deduced.

GEOLOGICAL SOCIETY OF LONDON.

Dr. F. A. Bather, M.A., F.R.S., presided over the meeting held on December 15, 1926. The following communication was read :—

A Revision of the Non-Marine Lamellibranchs of the Coal-Measures, and a Discussion of their Zonal Sequence. By JOHN HENRY DAVIES, F.G.S., AND ARTHUR ELIJAH TRUEMAN, D.Sc., F.G.S.

The paper deals with the Coal-Measure Lamellibranchs of the genera *Carbonicola*, *Anthracomya*, and *Naiadites*. As a result of the work of the late Dr. Wheelton Hind and others, the general sequence of the shells is known in Staffordshire and in certain other coalfields, but comparatively little attention has been paid to them in this country for some years.

The shells are remarkable for the breadth of variation at each horizon. Statistical studies of these variations are included in

the paper, and it is shown that in many horizons the shells constitute a homogeneous community. The problems of nomenclature in such series are discussed, and the importance of statistical analyses of the variations is recognised.

Various restrictions in the current use of specific names are suggested, and some new species are described. As a result of these changes in nomenclature, certain common species are considered to have a shorter range than was formerly thought to be the case.

A description of the sequence in South Wales is given; the following zones are recognised : —

(6) Zone of *Anthracomya* sp. nov.

(5) Zone of *Anthracomya phillipsii.*

(4) Zone of *Anthracomya pulchra.*

(3) Zone of *Carbonicola similis.*

(2) Zone of *Anthracomya modiolaris.*

(1) Zone of *Carbonicola ovalis.*

In the Zones 1 to 4 *Carbonicola* and *Naiadites* are common, with at least two series of *Anthracomya* in Zones 2 and 4 respectively; in these four zones marine bands occur at intervals. In Zones 5 and 6 *Carbonicola* and *Naiadites* are practically unknown, mollusca being represented by a limited number of species resembling *A. phillipsii*; marine fossils are extremely rare above Zone 4.

Prof. P. Pruvost has studied these shells in the North of France, and, from an examination of his specimens, it is concluded that the succession in the North of France is closely comparable with that in South Wales. The relative abundance of the various genera is different, possibly indicating somewhat different conditions of deposition; but the general changes in the fauna make it possible to distinguish the zones.

The sequence in North Staffordshire, determined mainly from a study of the Wheelton Hind Collection, is also discussed. It is concluded that the Lamellibranchs afford a reliable basis for the correlation of the Coal Measures, and especially of that part of the Coal Measures which contain the more important seams.

A general discussion followed.

NOTICES OF BOOKS.

Ancient Egyptian Metallurgy. By MAJOR H. GARLAND, O.B.E., F.C.S., M.Inst.Metals AND C O. BANNISTER, M.Eng. A.R.S.M., F.I.C. With frontispiece and 113 other illustrations. Price 12s. 6d. net. London : Charles Griffin & Co., Ltd., 42, Drury Lane, W.C.2.

Owing to the death of Major Garland prior to the completion of this interesting book for the press, practically all the editorial work devolved on Mr. Bannister. We learn, too, that a chapter on Gold and Silver which Major Garland had in preparation at the time of his death, is missing from the work. That is a pity, for the Egyptians were among the earliest investigators into the nature of these metals, and unquestionably Major Garland's residence and important official position in Egypt, made his an authority on the subject. As it is, the work is an important one, dealing as it does with the early history of Egypt as regards metals, the bronze industry, the iron age, ancient tools, metallography and notes for collectors of antique metal objects. There is given a good index and a complete index of the illustrations, which will be found very convenient for reference. The work is one that ought to meet with appreciation not only for its contents, but because it deals with subjects that are seldom dealt with, and those competent to write on the subject are strictly limited. It might be added that the work is handsomely bound.

Chemiker-Kalendar. 1927. Berlin : Verlag Julius Springer. Price, 18 marks.

The new editor of the *Chemiker-Kalendar*, now in its 48th year, is Dr. I. Koppel. He has divided it into three volumes. Part I. is the pocket-book with calendar, logarithm and some other tables, blank and squared paper. Part II. contains the large majority of the Tables of Constants and data such as densities and solubilities and analytical procedures. Part III. is the Theoretical section.

Among the special contributions, mention may be made of the following :— Emission-Spectra Analysis, by Professor Scheibe; Micro-Analysis, by Dr. Geilmann; Examination of Fats and Waxes, by Dr. Ludecke, and Practice and Statistics, by Dr. Scharf.

Table 1. of Volume II—"Properties of Inorganic Substances" — has been very thoroughly revised and made a valuable feature of this edition. The new editor welcomes suggestions for further improvements in future issues.

PUBLICATIONS RECEIVED FROM U.S. BUREAU OF MINES.

Asphalt and Related Bitumens in 1925, by G. R. Hopkins and A. B. Coons. 5 cents.

Feldspar in 1925, by Jefferson Middleton. 5 cents.

Platinum and Allied Metals in 1925, by J. A. Hill. 5 cents.

Graphite in 1925, by Jefferson Middleton. 5 cents.

Carbon Black Produced from Natural Gas in 1925, by G .R. Hopkins. 5 cents.

Gold, Silver and Copper in S. Dakota and Wyoming in 1924, by C. W. Henderson. 5 cents.

Annual Report of the Director of the Bureau of Mines for the Fiscal Year ending June 30, 1926.

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

Thursday, February 17, at 4.30 p.m.—" Wolfer's Sunspot Numbers Considered as a Disturbed Periodic Series." By G. U. Yule, F.R.S.

" Measurements of Ozone in the Earth's Atmosphere and its Relations to other Geophysical Conditions. Part II." By G. M. B. Dobson and D. N. Harrison.

" Meterological Perturbations of Tides and Currents in an Unlimited Channel Rotating with the Earth." By H. Horrocks.

UNIVERSITY OF LONDON.

University College, Gower Street, W.C.1.

Wednesday, February 16, at 5 p.m.—" How to Identify, Collate, and Describe Old Books." First of a Course of three public lectures by Mr. Arundell Esdaile, M.A., Secretary of the British Museum. February 16, 23 and March 2.

Thursday, February 17, at 5.30 p.m.—" ' The University Idea ' in the United States." A public lecture by the Academic Registrar, Mr. Edwin Deller, LL.D.

Thursday, February 17, at 5.30 p.m.—" The Ostracoderms, their Organisation and Relationship." First of a course of four public lectures by Professor E. A. Stensio, of the University of Stockholm. February 17, 18, 22 and 24. (Lantern Illustrations.)

THE ROYAL INSTITUTION.

21, Albemarle Street, W.I.

Wednesday,February 16, at 5.15 p.m.—" Animal Growth and Development." By Professor Julian Huxley.

Thursday, February 17, at 5.15 p.m.—" Acoustical Problems—Bells." By Sir William Bragg.

Friday, February 18, at 9 p.m.—" The Laws of Monetary Science." By Sir Josiah Stamp.

Saturday, February 19, at 3 p.m.—" The Supernatural in Fiction " By Mr. Walter de la Mare.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Monday, February 14, at 8 p.m.—(Cantor Lecture). Professor Ernest George Coker, M.A., D.Sc., F.R.S., M.Inst.C.E., Professor of Civil and Mechanical Engineering, University College, University of London : " Photo-elastic Measurements of Stress Distribution." Lecture I.

Wednesday, February 16, at 8 p.m. (Ordinary Meeting.) Clifford Copland Paterson, O.B.E., M.I.E.E.,F. Inst.P., General Electric Company's Research Laboratory, Wembley : " Some Studies in Electric Lamps and Valves." (Illustrated by experimental demonstrations.) Sir Oliver J. Lodge, M.A., LL.D., D.Sc., F.R.S., will preside.

INSTITUTE OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment. London.

Thursday, February 17, at 6 p.m.—F. H. Clough, C.B.E. :" The Stability of Large Power Systems."

Liverpool Centre, at Laboratories of the University of Liverpool. — Wednesday, February 16, at 7 p.m.—Joint Meeting with the Engineering Society, at the Temple, Dale Street.

South Midland Centre, The University, Edmund Street, Birmingham, at 7 p.m.—Wednesday, February 16.—P. Dunsheath, O.B.E., M.A., B.Sc. : " 33,000-Volt Cables with Metal-Sheathed Cores, with Special Reference to the S. L. Type."

Western Centre.—Monday, February 14, at 7 p.m.—W. M. Selvey : " Power Stations and Their Equipments," at the S. Wales Institute of Engineers, Cardiff.

Sheffield Sub-Centre, at the Mappin Hall, Applied Science Department, St. George's Square.—Wednesday, February 16, at 7.30 p.m.—Dr. E. V. Pullin : " The Application of X-rays to the Examination of Metals."

THE FARADAY SOCIETY.

OXFORD MEETING, APRIL 22-23, 1927.

A General Discussionon " The Theory of Strong Electrolytes," will be held at Oxford as follows :—

Friday, April 22, from 3.30-5; and 5.45-7.15 p.m.—Part I. " Ionic Mobility."

Saturday, April 23, from 9.30-11; 11.30-1; and 2.15-3.45. Part II. " Activity of Strong Electrolytes."

Among those who have signified their intention of attending the meeting are Professor A. J. Allman (London); Professor J. N. Brönsted (Copenhagen); Professor N. J. Bjerrum (Copenhagen); Professor J. A. Christionsen (Copenhagen); Mr. C. R. Bury (Aberystwyth); Professor F. G. Donnan (London); Mr. R. H. Fowler (Cambridge); Professor K. Fajans (Munich); Dr. H. Goldschmidt (Christiana); Mr. H. B. Hartley (Oxford); Professor G. von Hevesey (Copenhagen); Dr. E. Hückel (Zurich); Professor T. M. Lowry (Cambridge); Professor A. W. Porter (London); Mr. H. R. Raikes (Oxford); Dr. E. K. Rideal (Cambridge); Dr. N. V. Sidgwick (Oxford); Dr. Ulich (Rostock). In addition, contributions to the proceedings have been promised by Professor P. Debye (Zurich), Dr. C. A. Kraus (Worcester, Mass.), Dr. D. A. MacInnes (Cambridge, Mass), Professor J. R. Partington (London), Professor W. C. McC. Lewis (Liverpool), some of whom hope to attend the meeting.

Arrangements are being made to accommodate Members attending the meeting at Exeter and Lincoln Colleges. The accommodation kindly put at the disposal of the Society is strictly limited, so that early application should be made. An inclusive charge of £1 2s. per head (excluding gratuities) will be made to Members to cover tea and dinner (including wines) on the Friday, sleeping accommodation Friday night, breakfast, lunch and tea on the Saturday. The charge to non-members will be 30s.

Arrangements are being made with the railway companies whereby it is hoped that tickets at reduced dates will be available for those attending the meeting.

THE PHYSICAL SOCIETY.

Friday, February 18, at 5 p.m., at the Rooms of the Astronomical Society, Burlington House. — " Waves in Granular Material," by Dr. G. Vaughan Cornish.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

1,419.—Adelantado, L.—Manufacture of phosphate fertilisers. January 17.

1,389.—Stettiner Chamotte Fabrik Akt.-Ges. vorm Didier. — Ovens for chemical processes.

1,363.—I. G. Farbenindustrie Akt.-Ges. —Concentration and distillation of hydrogen peroxide solution. January 17th.

1,399.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of keto alcohols. January 17th.

1,611.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of unsaturated aldehydes. January 19th.

Specifications Published.

264,237.—Hatfield, H. S.—Means for effecting the chemical analysis of liquids.

253,128.—Distilleries Des Deux-Sevres.—Process and apparatus for the simultaneous dehydration and the purification of alcohol.

254,288.—Fischer, Dr. F. and Tropsch, Dr. H.—Process for purifying gases from sulphur.

Abstract Published.

262,447.—Phosphic acid.—I. G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany.

Hydrogen.—The steam for the production of phosphoric acids and hydrogen by the interaction of steam and phosphorus is recovered to a large extent from the residual gases by passing them into a water-cooled condenser maintained at a temperature of 100° C., or above which thus acts as a steam generator. The uncondensed gases then pass to a second water-cooled condenser maintained below 100° C., whereby the hydrogen is completely freed from water and simultaneously steam below atmospheric pressure is produced. By compressing this further quantity of steam it is raised above atmospheric pressure and becomes available for re-use. In a modification the first condenser maintained at a temperature about 100° C. is dispensed

with. Tin, bronze, aluminium bronze, ferrosilicon and an alloy of copper, aluminium and iron may be used for the condensers which in an example take the form of a tube boiler.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

TRANSPULMIN.

475,119.—Chemical substances prepared for use in medicine and pharmacy.—Chemische-Pharmazeeutische Aktiengesellschaft Bad Homburg, Dorotheenstrasse 45, Bad Homburg vor der Hohe, Germany. January 19th.

SEZATONES.

473,562.—All goods in Class 3, which includes chemical substances prepared for use in medicine and pharmacy. — Evans and Sons, Lescher and Webb, Limited, 56, Hanover Street, Liverpool. January 26th.

STOVARSOLIQUE .

475,842.—Chemical substances prepared for use in medicine and pharmacy.—Les Etablissements Poulenc Freres, 92, Rue Vieille-lu-Temple, Paris, France. January 26th.

STOVARSOLATE.

475,843.—Chemical substances prepared for use in medicine and pharmacy.—Les Etablissements Poulenc Treres, 92, Rue, Vieille-du-Temple, Paris, France. January 26th.

JAD.

475,024.—Medicinal salts for human use.—Wyeth Chemical Company, Dupont Building ,7, West 10th Street, Wilmington, Delaware, United States of America. January 26th.

FRENCHMAN is prepared to give Lessons in French Grammar and Conversation.—Write, "C," c/o *Chemical News*,

BRITISH PATENT 121,294.

IMPROVEMENTS IN EXPLOSIVES.

The Owner of this Patent wishes to grant Licences or to come into relation with someone for the Industrial Working of his Patent.

For particulars, write to A. VAN DAMME, 7, Rue du Montenégro, Brussels, Belgium.

BRITISH PATENT NO. 228595.

The Owners of British Patent No. 228595 for MANUFACTURE OF MERCURIAL PHENOLS, are desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above Invention, either by Sale of the Patent Rights, or by the Grant of Licenses to Manufacture on Royalty.

Enquiries should be addressed to Messrs. ABEL & IMRAY, 30, Southampton Buildings, London, W.C.2.

STEPHEN JAMES RALPH

on the death of his Mother, BITHIAH RALPH, of Balham, became entitled to her Estate. Information as to his whereabouts after 1920 is required by the Administrator, The Public Trustee, Kingsway, London.

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A SELECTIVE DISPLACEMENT OF 0.0153A IN X-RAY SPECTRAL LINES. PART II.

By F. H. LORING.

In the *Chemical News* of February 4, 1927, cxxxiv., 65, it was shown by the writer that certain unidentified X-ray lines could be brought into agreement with known lines by adding thereto the value 0.01527A, or a figure very close to this one.

Since, as a side issue, some comments in connection with Planck's constant were introduced in the first part, it may be of general interest to traverse some familiar ground and briefly sketch the main fundamentals involved in radiation phenomena. In making this elementary survey, the above constant, referred to briefly as Δ, will be introduced and some further conclusions tentatively drawn.

1 Angström unit (A) has a wave-length of 0.00000001 cm. = 10^{-8} cm. X units (X) are 1,000 times larger than A units. A micron, μ, is a thousandth of a mm., but not usually used for short wave-lengths. $\mu = 10^{-4}$ cm. $\mu\mu = 10^{-7}$ cm.

Wave-lengths per cm. in a vacuum = wave-number.

Wave-length in A units = λ_a.

Therefore, $10^8/\lambda_a$ = wave-number = ν_{cm}. Or this may be otherwise expressed as

$$1/\lambda_{cm} = 1/(\lambda_a \times 10^{-8}) = \nu_{cm}.$$

Frequency of waves, per second = ν_{sec}.

Planck's constant = $6.5487 \times 10^{-27} = h$. (See previous article showing why this particular value of h is here used.)

Wave-energy,* or specfically a quantum of radiant energy = $h\nu_{sec}$ = E. h is often referred to as an *element of action* (energy × time). A parallel expression would be a *quantum of action.*

Difference-value expressed as Δ_a = 0.01527A.

Wave-number of $\Delta_a = 10^8/\Delta_a = \nu_{cm} = 6.5487 \times 10^9$.

Planck's constant, taken as above, is to the waves per cm. for Δ as 1 is to 10^{36}, as near as can be judged (see previous part)

* The definition of $h\nu_{sec}$ as *wave-energy* might be questioned. One may be able to fill a reservoir with a pump that delivers so many gallons of water per second; and, conversely, one may remove the water with the same pump in gallon lots, or gallons per second. This does not mean that the water in the reservoir has a gallon sub-division, for the water spreads like radiation. There is, however, experimental evidence of directed quanta, referring to radiation, but $h\nu_{sec}$ is best thought of as the quantum that is delivered or taken up by the atomic pump. The analogy is imperfect, as most analogies are, but it may serve to show that radiation in space, or its equivalent, is not necessarily done up in bundles of energy. The photo-electric effect appears to involve the seemingly impossible absorption of a quantum of radiant energy, although this energy as radiation has spread out enormously. There is thus a quantitative difficulty. Using the above analogy, it is like pumping gallons of water per second from a foggy atmosphere—quite absurd, of course, with limited pumps.

Velocity of light in a vacuum is 2.9986 $\times$ 10^{10} cms. per second $= c$. The wave-length λ_{air} will differ from λ_{vac} as 1 is to 1.0002918, according to the equation: (*velocity of light in vacuo*)/(*velocity of light in air*) = 1.0002918 $= \mu$, the refractive index. Otherwise expressed (Fowler): $\lambda_{vac} = \mu\lambda_{air}$; or, $\Delta\lambda = \lambda_{vac} - \lambda_{air} = \lambda(\mu - 1)$. $\Delta\lambda$ here is defined by the equation.

If there are ν_{cm} waves in *one* cm., then in 2.9986 $\times$ 10^{10} cms. there would be this figure times as many more, therefore—

Frequency per sec., ν_{sec}, in a vacuum is $c\nu_{cm}$. Also $\nu_{sec} = c/\lambda_{cm}$. And $\lambda_a \times 10^{-8} = \lambda_{cm}$.

Therefore, $E = hc\nu_{cm}$.

Transposing the constant c to the left-hand side of the equation gives $E/c = h\nu_{cm}$.

Similarly, transposing the constant h, the equation becomes: $(E/c)/h = \nu_{cm}$.

ν_{cm} is in this case a ratio of h to E/c.

Supplying figures, the final equation above is—

$$\frac{(1.2859637\ldots \times 10^{-6})/(2.9986 \times 10^{10})}{6.5487 \times 10^{-27}} = 6.5487 \times 10^{9}.$$

Writing 6.5487 = K, the following applies in this particular case—

$$E/c = h\nu_{cm} = K^2 \times 10^{-18}; \text{ or}$$
$$h\nu_{cm} = K\nu_{cm} \times 10^{-27}.$$

If now the frequency be reduced to unity (1), with a consequent wave-length of 2.9986 $\times$ 10^{10} cms., then h becomes the unit of energy† (h value unchanged), so that the above ratio is the ratio of this unit energy to that of the frequency per cm. as expressed in wave-number which is K $\times$ 10^9. That is to say, there are 10^{36} h's apparently involved in 1 cm., as against 2.9986 $\times$ 10^{10} cms. (= distance travelled by light in one second).

Whatever this may mean, there is the suggestion that the quantity expressed in Angströms, *viz.*, 0.01527 is, if it can be treated separately (?), a sort of unit, and it may therefore occur in integral multiples $n\Delta$, n being any number, 1, 2, 3, etc.

Considering favourably this suggestion, the following table has been prepared. The first part contains the remaining values as obtained by J. S. Rogers that were not properly identified previously. The second part contains the values of C. J. Lapp, R. A. Rogers, and B. S. Hopkins, also not fully or properly identified before. For references, see previous part. Other identifications than those here, and before shown, can be tried, having regard to the other lines on the plates. Values in table A units.

x-line	$x + 2\Delta$	$x + 3\Delta$	Identification.		Difference.
1.2487	1.27924		$WL\beta_1$ =	1.27917	+ 0.00007
1.2300	1.26054		$WL\beta_3$ =	1.26000	+ 0.00054
1.5878	1.61834		$DyL\beta_2$ =	1.6198	− 0.00146
1.5486		1.59441	$EuL\beta\gamma_2$ =	1.5939	+ 0.00051
1.3753		1.42111	$LuL\beta_1$ =	1.4207	+ 0.00041
1.3604	1.39094*	1.40621 ?	$ErL\gamma_5$ =	1.403 ?	
1.2487	1.27924		$WL\beta_1$ =	1.27917	+ 0.00007

* Near to $CuK\beta_1$ line $\lambda \times$ 1.38887, as given by Siegbahn's book; or, λ = 1.38929 —a recent determination by A. Leide (*Zeit. für Physik*, 1926, XXXIX., p. 686). The line 1.3441 + 3Δ is near to the latter Cu line (see previous part).

† It is not here intended to depart from the accepted idea in respect of h; and to put the reader, who has not studied the subject, right in the matter, the following from "The New Theories of Matter and the Atom," by A. Berthoud (translated by Eden and Cedar Paul) will be quoted:—"The quantum $h\nu$ represents quantity of energy, but it is otherwise with the constant h. This magnitude has the dimensions of an *action*, that is to say, of the product of a quantity of energy by the time. Now, the new form of Planck's theory shows that what varies by equal quantities is not energy but action. The *quantum of action* is nothing else than the constant h. For this reason, it is not, like the quantum of energy, a variable quantity. In all the phenomena, of whatever kind, in which an electron forfeits energy, the variation of the action is equal to an integral multiple of h."—P. 210.

The appearance of several Dy lines (correct the value 1.4501 to read 1.4051 in the previous part) suggests that the β_1 (1.6927) and β_2 (1.5878) lines should have been strong on the negative, particularly the former. Compare Lu$L\alpha_1$ and Ta$L\beta_7$ and Ta$L\beta_2$.

Some of the lines may be " split-off " lines from the normal lines, to introduce an idea proposed, or endorsed by V. Dolejsek in connection with certain other lines (see *Nature*, 1925, CXVI., 782.)

It must be clearly understood that the $\Delta\lambda$ quantity, abbreviated to Δ or Δ_a, is not an independent X-ray emission, though the calculations here given are so split up as to suggest such a possibility. If there was such a short-wave-length radiation of 0.01527A, then applying the quantum theory, that is to say, using the well-known equation, $E = eV \times 1/300 = h\nu_{sec} = hc/\lambda_{cm}$, the voltage ($V$) necessary to excite this high-frequency radiation would be about 800,000, assuming that the equation applies in such an extreme case. Should the general reader wish to make the simple calculation, he can do so, making $e = 4.774 \times 10^{10}$, which is the well-known charge of an electron in electrostatic units (E.S.U.). 1/300 is, of course, the conversion multiplier used in changing over ordinary volts to the E.S.U.

One might, however, suspect, from relativity considerations (if, as below, there is a small loss in mass), that if an element is synthetically formed in the X-ray tube energy would be emitted as very short wave-length Röntgen radiation, which would fit into the scheme of the foregoing equations. So far as the writer's experience extends, there is no such high-frequency radiation emitted from the X-ray tube when more or less successful attempts were made to form elements (see Loring, *Chem. News*, 1926, CXXXII., 311; CXXXIII., 356), though complete plate-fogging occurred on several occasions, but this was traced to other common causes.

Paneth and Peters (*Berichte*, 1926, Sept. 15, p. 2039), claim to have condensed, so to speak, hydrogen into helium using palladium as a catalyst. This was accomplished at room temperature. They do not report the presence of any high-frequency radiation, though a small loss of mass should have occurred if the newly-formed helium has the same atomic weight as atmospheric helium.

The present writer has attempted to combine elements to form new elements in the X-ray tube (*loc. cit.*); and the condensation of acetylene, as accomplished by Coolidge with his new cathode-ray tube, was cited as showing that these rays, and possibly X-rays, acted apparently as a catalyst, an ideal condensation being figured along element lines as a parallel; but until more particulars are available it would be premature to draw any definite conclusion. In this connection, see *Chem. News*, Loring, Dec. 31, 1926, p. 419; and Szymanowitz, Feb. 4, 1927, p. 75.

Summary and Comments.

Some elementary explanations of the fundamentals used in connection with radiation formulæ are given by way of introduction. A unit $\Delta\lambda$ value of 0.01527A is considered in reference to Planck's constant taken as a unit of energy when the frequency reduces to unity; and without a full development it is thought that integral multiples of Δ might be tried to see whether these would by addition make the originally unidentified values identifiable, as previously done (*loc. cit.*). The results are good, but not, perhaps, conclusive. 1.4501 in the previous part should read 1.4051.

It is to be noted that although figures are given extending well into the decimal region, the data are not sufficient to establish such values implicitly. Besides it is difficult to exclude both chance coincidences and the human error. There are in point of fact 3 errors to consider: 1, that of the x-value; 2 that of the Δ value; 3, that of the standard measured value; but on the whole the agreements support the Δ value obtained.

As regards the accuracy of the wave-length determinations, it may be noted that in a recent work of considerable magnitude A. Leide (*loc. cit.*) obtained the value for the $K\beta_1$ line of copper as 1.38929. Siegbahn in his book (1925) gives the value as 1.38887. There is thus a difference of 0.00042A in the case of this line! Therefore, pressing agreements in the fifth and sixth places of decimals is absurd, but the reader can allow for this.

Incidentally, Leide obtained for the RuK series the following values :—

α_2	=	0.64615	β_1	=	0.57143
α_1	=	0.64181	β_2	=	0.56048

The $K\beta_1$ line is very close to the present writer's estimated value, 0.57158, the calculated value being 0.57133 (see *Chem. News*, 1927, CXXXIV., 49). That these determinations had been made escaped the writer's attention at the time of publication, the work being recent. Leide does not give any determinations for Pr and Ga.

HUMUS: ITS CONNECTION WITH THE NOURISHMENT OF FOREST LIFE.

By J. PEKLO.

(*Professor of Plant Physiology at the Technical University of Prague*, 1926.)

(Abstracted from *Zemědělský Archiv*, Prague.)

This work gives an account of the humus colloids and recent work upon humus in England and America together with new original studies on the humus found in Czech forests.

In continuation of the studies of the biology of humus it is pointed out that much of the nourishment assimilated by plant growths, for example, in the Bohemian beech forests is obtained by symbiotic processes through mycorhiza. In the decomposition of the leaf deposits on granite soils the mycorhizæ form the real layers where the secretion of the enzyme, cellulase, takes place. In this way the nitrogen compounds are set free and are mineralised and made available for re-absorption by the fungi-tree rootlets of the beech trees. In the Bohemian Picea forests large quantities of mycorhiza are to be found and the author suggests the possibility that the fungi are able to bring nitrogen compounds directly into symbiotic trees. He mentions that also in Denmark it has been observed that the symbiotic fungi isolated from Picea mycorhiza are able to assimilate free nitrogen from the air and as a result of comparisons made in the forests of several European countries, the author finds strong support for his views. The work of Miss Rayner dealing with the mycorhiza of *Calluna vulgaris*, which also most probably assimilates free nitrogen as well as the symbiotic forest orchid, *Neottia nidus-avis*, which is known to do so, also confirms these views.

Finally it is noteworthy that a great deal of tannin is localised in mycorhiza tissues and is consumed by the fungus which serves as food for many forest fungi.

General Notes.

THE PHYSICAL SOCIETY.

During the year fourteen ordinary science meetings have been held at the Imperial Collece of Science. The Director of the National Physical Laboratory kindly invited the Society to visit the Laboratory on May 22, but this visit had to be cancelled owing to difficulties arising from the industrial situation in the country. For the same reason the Council did not arrange a provincial meeting, like those successfully held in 1924 and 1925; but a visit to Bristol will probably be made in 1927.

At the science meetings 32 papers were presented and 12 demonstrations were given.

Professor Charles Fabry, who was elected an Honorary Fellow of the Society at the Annual General Meeting, delivered the Eleventh Guthrie Lecture on April 23, the subject being " The Absorption of Radiation by the Upper Atmosphere." About 105 Fellows and Visitors were present.

The average attendance at the meetings of the Society was 54.

The Sixteenth Annual Exhibition, arranged jointly by the Physical and Optical Societies, was held, through the courtesy of the governing body, at the Imperial College, on January 5, 6, and 7.

Dr. Owen and Dr. J. H. Vincent have been appointed representatives of the Society on the Board of the Institute of Physics, and Mr. J. Guild and Dr. D. Owen on the Science Abstracts Committee. Mr. F. J. W. Whipple has been reappointed as the Society's representative on the Geophysical Committee of the Royal Astronomical Society, and Professor E. A. Owen has been appointed to represent the Society on the International X-ray Unit Committee.

Professor O. W. Richardson and Mr. F. E. Smith represented the Society at the Coming-of-Age Celebrations of Sheffield University on July 1 and 2, and conveyed to the University an Address of Congratulation on behalf of the Society.

The Council has awarded the Fourth Duddell Medal to Mr. F. Twyman, F.R.S. This was presented at the Annual General Meeting.

On December 31, 1926, there were 12 Hon. Fellows, 666 Ordinary Fellows, and 12 Students on the Roll of the Society.

CANADA DEVELOPING IMPORTANT SOAPSTONE INDUSTRY.

Canadian sulphate pulp mills are estimated to use in the neighbourhood of 2,500 tons of soapstone per year. This stone is employed in the form of sawn blocks and bricks for building the furnaces used in recovery of the alkali or black liquor from the digestors, and is the only natural product known that will satisfactorily resist the action of the molten alkali. Since the

recovery of such alkali is of great moment in kraft mill practice, it follows that soapstone is a very important material to the pulp mill operators.

Prior to 1922, little attention had been directed towards developing a domestic supply of soapstone, and the requirements of the mills were not entirely by imported stone, most of which came from the United States. In 1922, the Mines Branch in a published report (Memorandum Series, No. 4) drew attention to what appeared to be a promising deposit of soapstone in the Lake of the Woods region, in Western Ontario. Following this, two companies were formed to exploit soapstone in this region, but these have not so far commenced operations. A third company, however, started work in 1925 in the same district, and has opened a small quarry and installed a sawing plant to cut soapstone blocks and bricks.

CHEMICALS AT THE BRITISH INDUSTRIES FAIR.

A Dominating Stand.

Preparations for the British Industries Fair are proceeding apace at the White City. For example, a casual inspection of the preparations being made in the Chemical Section leave no room for possible doubt that the stand of the great company now known as Imperial Chemical Industries Limited will be the dominating feature of that section. A novel and striking design is being carried out — in fact, in some respects the exhibit might almost be described as an edifice rather than a stand.

Manufacturers of metal and metal goods are themselves huge consumers of chemicals of various kinds, *e.g.*, sulphuric and nitric acids. Sulphuric and nitric acids may not in themselves make an appeal to metal workers and engineers interested in their own trade, but when they see them coupled with articles of brass or brass sheet and other non-ferrous metals, the connection at once becomes apparent. Lime and limestone are also used in large quantities in foundries and smelting works.

The agriculturist may not at once see the relationship between chemicals and the plough, but associated with Imperial Chemical Industries is Nitram Limited, the newly-formed company who are acting as sole agents not only for the British Sulphate of Ammonia Federation Ltd., but also, we understand, for other fertilisers, etc., for Imperial Chemical Industries Limited. This concern will have an attractive display on the Imperial Chemical Industries stand, showing the use of chemicals in the production of food-stuffs and cereals of all kinds, as well as vegetables, while the indirect effect chemicals have through fertilising meadowland upon butter, milk and meat production will be seen.

The organisers of the stand of Imperial Chemical Industries are taking full advantage of the fact that the British Industries Fair will be thrown open to the public after 5 o'clock, and are putting up an attractive exhibit which will not only appeal to the trade buyer during the daytime, but will make an instinctive public appeal in the evening, when the London worker, being a wise man, will take his family to the White City to see some of the wonders of British trade.

CHEMICALS, ETC., FOR EGYPT.

The Commercial Secretary at Cairo (Mr. E. H. Mulock) reports that the Egyptian Ministry of Agriculture are inviting tenders for the supply of the following goods required during 1927-28.

(a) Nitrate of soda.
(b) Nitrate of lime.
(c) Sulphate of ammonia.
(d) Superphosphate of lime.
(e) New bags for bagging the nitrate of soda.
(f) New sacks for sacking cotton seed (Tagawi).
(g) Twine (coloured blue).
(h) Pieces of tin for sealing.

Tenders will be received by the Ministry of Agriculture, Sharia Dar el Niaba, Cairo, up till the 21st March, 1927. In the case of certain quantities of nitrate of soda required, the latest date for the receipt of tenders is June 7, 1927.

Local representation is essential, and the Overseas Trade Department, 35, Old Queen Street, London, S.W.1., is prepared to furnish United Kingdom firms desirous of tendering and not represented in Egypt, with the names of British merchant houses with Egyptian connections who may be willing to handle tenders on their behalf.

AGRICULTURE AND GENERAL ENGINEERS LIMITED.

This company, which controls a large number of British engineers ,is to be represented in South Africa by Major G. Featherstone, who has resigned his position as British Trade Commissioner for South Africa to take the new appointment.

WHOLESALE PRICES IN JANUARY.

Board of Trade Index Number.

As registered at the Board of Trade, the average of wholesale prices in January shows a fall of 1.7 per cent. compared with December, the index numbers for the two months being 86.4 and 87.9 respectively (1924 = 100). This fall, following a decrease of 4.2 per cent. in December, reduces the general average to the same as that for April last. The January indices show reductions in six of the eight groups of commodities, the exceptions being food other than cereals, meat, and fish, which rose by 1.7 per cent., and miscellaneous industrial materials, which rose by 0.2 per cent. The average for food fell from December to January by 1.0 per cent., cereals having cheapened by 1.0 per cent., and meat and fish by 3.9 per cent. For industrial materials a fall of 2.1 per cent. was recorded, iron and steel being down by 2.2 per cent., and other metals and minerals by 7.1 per cent. Further reductions in the prices of cotton materials reduced the level for that group by 0.4 per cent., while the average for other textiles fell by 0.3 per cent., comparing the January figures with those for December.

DIVISION OF CHEMISTRY, DEPARTMENT OF AGRICULTURE, SOUTH AFRICA.

The report for the year ending June 30, 1926, is a record of useful work. The headquarters of the division are now at Pretoria, with branches at Cape Town and Johannesburg, and also at the five Schools of Agriculture. The chief of this important division is St. C. J. Sinclair, M.A., D.Sc., F.I.C.

Abstracts from Reports of the Division's Officers in Charge of Laboratories.

At Johannesburg.

(J. McCrae, Ph.D., F.I.C., Government Analyst.)

The aggregate number of samples examined during the year was 5,179, the tariff value of services rendered being £11,623 3s. 6d. The specimens dealt with included 1,465 samples of foods and drugs, 524 wines and spirits, 411 minerals, 405 waters, 278 exhibits in cases of human and animal poisoning, 192 poisons, 238 explosives, 202 leathers, 164 samples of liquor in connection with illicit liquor cases, and 118 specimens of gold and gold-bearing material.

An apparatus for the electrolytic determination of arsenic was devised by Messrs. J. Moir, M.A., D.Sc., F.I.C., and J. S. Jamieson, F.I.C., and is now commercially obtainable.

A certain measure of research work was undertaken. Its nature is reflected in the papers contributed by Dr. McCrae and Dr. Moir.

At Capetown.

(B. de C. Marchand, B.A., D.Sc., Senior Chemist.)

The total number of specimens examined during the year was 3,021, the tariff value of services rendered being £4,915 12s. Included in the above samples were: 1,315 samples of foodstuffs under the Sale of Food and Drugs Act (Cape) (including 941 fresh milk), 292 minerals, 255 wines and spirits, 217 fertilisers, 199 specimens of fruit (oranges, pears, apples, and apricots), and 32 eggs.

The work of the Institution included investigation in regard to—

(a) Composition of Turkish tobacco; (b) composition of grapes and the changes they undergo during ripening and storage; (c) composition of South African honey; (d) the effects of certain waters when used in locomotive boilers; (e) arsenic-content of apples and pears from sprayed trees; (f) methods for the determination of sulphur dioxide in dried fruit; (g) certain deposit of wolframite in the Cape Province.

At Pretoria.

(A. Stead, M.Sc., F.I.C., Senior Chemist.)

The total number of samples analysed in the laboratories was 1,024. Of this number 632 were samples of soil examined in connection with irrigation and land settlement schemes and the research work of the Institution. A large number of tests was also carried out by soil survey officers in the field. Work in connection with the deterioration of pineapple lands was continued. Besides its soil investigations, the Institution dealt with various matters, such as, for instance, the suitability of certain preparations of calcium arsenate as a dusting powder for the destruction of the eucalyptus snout-beetle, and the influence of certain sprays upon the fruit.

In addition to his other duties, the Senior Chemist continued to have charge of the Union Soil Survey.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting on Thursday, February 3 :—

The Initial Stages of Gaseous Explosions. Part I. Flame Speeds during the Initial "Uniform Movement." By W. A. Bone, F.R.S., R. P. Fraser, and D. A. Winter.

The paper embodies the results of an experimental investigation upon the nature of the initial movement of flame when a gaseous explosive mixture is ignited at the *open* end of a horizontal tube 2.5 cm. in diameter, and is especially directed towards a better understanding of what is usually known as the "uniform movement" in such circumstances. The explosive mixtures examined have been chiefly hydrogen-oxygen, ethylene-oxygen, and acetylene-oxygen mixtures.

It is shown, in such cases, that so long as the initial flame speed does not exceed about 4,000 cm. per second, there is a quite definite intital "uniform movement," the speed of which, under standard conditions of experiment, was nearly always fairly constant. But with initial flame speeds exceeding such limits, ethylene-oxygen and acetylene-oxygen mixtures no longer showed any "uniform movement" at all; on the contrary, the flame speed was continuously accelerated *ab initio* until detonation is set up, just as though the explosive mixture had been fired near the *closed* end of the tube.

In the case of hydrogen-oxygen mixtures, whilst the uniformity of the initial movement was still maintained, its speed tended to vary considerably in successive experiments, even though, so far as can be judged, all conditions were kept the same, so sensitive are such fast-burning mixtures. Other experiments showed that, in certain circumstances, a slow "uniform movement" of flame can be developed in an explosive mixture after an initial period of continuous acceleration. Therefore, it would seem that the speed at which a slow uniform flame movement can travel through an explosive mixture cannot be regarded as a physical constant of it, in the same sense as its rate of explosion (that is, detonation).

The Initial Stages of Gaseous Explosions. Part II. An Examination of the Supposed Law of Flame Speeds. By W. A. Bone, F.R.S., R. P. Fraser, and D. A. Winter.

This paper embodies the results of a systematic experimental testing, by the method of blending, of the "law of flame speeds" propounded by Prof. R. V. Wheeler and Dr. W. Payman in 1922, which says that, "given two or more mixtures of air or oxygen with different individual gases, in each of which the speed of propagation of flame is the same, all combinations of mixtures of the same type (*i.e.*, all containing excess of oxygen or all containing excess of combustible gas) propagate flame at the same speeds, under the same conditions of experiment."

The mixtures used for the tests have included several complex hydrocarbon and hydro-oxygen mixtures, in which the hydrocarbon has been either acetylene, ethylene, or methane; also a series of complex methane-hydrogen-air mixtures, all containing excess of combustible gas, have been examined. In no case have the requirements of the "law" been fulfilled.

In cases in which ethylene or methane was the hydrocarbon used, and the primary mixtures both contained excess of combustible gas, it has been shown experimentally that the effect of successive additions of the primary hydrogen-oxygen mixture to the primary hydrocarbon-oxygen mixture (both having the same initial uniform flame speed) is progressively to depress the initial uniform flame speed of the resulting complex mixture, until it refuses any longer to propagate flame. It therefore follows that, whatever measure of truth there may be in Payman and Wheeler's conclusions in regard to particular instances, they are not generally applicable to gaseous explosions, and therefore cannot be vested with the authority of a natural law.

On Detonation of Gaseous Mixtures of Acetylene and of Pentane.—I. By A. Egerton, F.R.S., and S. F. Gates.

(1) The conditions for detonation to occur in the same place in a tube of certain dimensions have been investigated for acetylene and for pentane mixtures of definite composition.

(2) The effect of change of composition and of nature of diluent gas on such position has been determined.

(3) Detonation appears to take place slightly ahead of the combustion front.

(4) The "anti-knock" compounds, lead tetraethyl and diethyl-selenide, were not found to affect the position of detonation at ordinary initial pressures and temperatures.

On Detonation of Gaseous Mixtures at High Initial Pressures and Temperatures.—II. By A. Egerton, F.R.S., and S. F. Gates.

(1) Detonation in acetylene and in pentane mixtures at high initial temperatures (230° C.) and pressures (10 atmospheres) has been investigated photographically, using a steel tube fitted with glass windows.

(2) Increase of initial pressure engenders earlier detonation up to a certain limit, when further increase makes very little difference.

(3) The effect of increase of initial temperature was also investigated. At a given initial pressure, rise of initial temperature appeared to render detonation slightly later.

(4) Lead tetraethyl was not found to affect the position of detonation at high pressure either at normal initial temperature or at 23° C.

SOCIETY OF GLASS TECHNOLOGY.

At the meeting of the Society of Glass Technology, held in Manchester on January 18 and 19, 1927, the following papers were presented :—

The Effect of Cullet on the Melting of Glass. By PROFESSOR W. E. S. TURNER.

In the course of his remarks, Professor Turner said that cullet was used largely for economical reasons and the desire to use waste materials. The amount of cullet mixed in batches might vary very greatly, according to the type of glass being made and according to the method by which the glass was being worked out.

The questions they had to consider were what was the effect on the melting and on the working of glass; and what was the cause of the change in the working properties of glass as the amount of cullet changed. It had been stated, said Professor Turner, that manufacturers using all cullet never succeeded in getting seed-free glass. With regard to the influence of cullet on the working properties, it would appear that after a certain proportion of cullet was reached, the glass became stiffer and stiffer to handle. The important question was, how much cullet could be employed, especially in machine working. With a large proportion of cullet in the batch, the viscosity of the glass tended to become high and the working range to become shorter. Why did this happen? The usual explanation was that there was a volatilisation of aklali and the glass became stiffer and stiffer. Experiments, however, did not substantiate this, as was indicated in the results of certain meltings. V. H. Stott, in a recent paper to the Society, found that it was only between 1500° and 1600° C. that volatilisation of alkalis began to be a factor. Was there then some change in molecular state which influenced the viscosity? How far real viscosity was affected was a problem still to be settled. There was something far more reaching than change of chemical composition.

Investigation of the Glassy State by the Method of Forced Crystallisation. By PROFESSOR J. F. PONOMAREFF (Tomsk, Siberia).

In glass the ability to spontaneous crystallisation was so weakly expressed and its speed was usually so small, that in ordinary conditions of cooling the molecules of glass had no definite position in the space lattice which accounted for the formation of the crystalline structure. Accordingly the substance chilled in an amorphous state producing glass. The method of forced crystallisation made it possible to crystallise every glass and to determine the temperature of the beginning of crystallisation, as well as the melting point of the newly-formed crystals. In the glass under investigation a constant lowering of temperature was maintained, so that the temperature was reached at which the number of spontaneously forming nuclei reached its maximum value. This value could be very small, as in his study of acid borates of sodium in mixtures approaching pure B_2O_3, which he was obliged to maintain at such temperature condition for three weeks uninterruptedly until the crystals began to form.

The method of forced crystallisation could be used for determining the temperature and speed of devitrification. It should also be used in research work with organic pitch-like substances which resembled glasses in their properties; also in the case of carbohydrates, glycerine and explosives. In conclusion, Professor Ponomareff gave a definition of glass which he believed to be the first approach to a precise characterisation of glass. His definition was : "A substance is to be regarded as a glass, independently of its chemical composition, which, being a strongly under-cooled fusion, gives on crystallising from the molten mass, crystals of the same chemical composition as the mass itself."

The Durability of Some Soda-Lime-Magnesia Glasses. By VIOLET DIMBLEBY, M.Sc., AND PROFESSOR W. E. S. TURNER.

A series of glasses was tested by the powder method. The first member of the series was obtained by the replacement of 0.2 molecule of CaO by 0.2 molecule of

MgO, in the parent glass, 6 SiO_2; 1.2 Na_2O; 0.8 CaO. Succeeding members of the series were obtained by the gradual replacement of CaO by MgO molecularly. The boiling reagents used were water, hydrochloric acid of constant boiling strength, and twice normal caustic soda solution.

From the results obtained it was concluded that the gradual molecular substitution of magnesia for lime produced the following effects :— (1) Durability towards boiling water was slightly enhanced; (2) resistance to attack by boiling hydrochloric acid was slightly impaired; (3) resistance offered to action of boiling caustic soda solution was somewhat decreased.

The Present Position of the Glass Industry in Germany. By PROFESSOR W. E. S. TURNER.

The greatest concentration of the glass industry in Germany was in the Lausitz district; indeed, the Germans claimed this to be the greatest concentration of glass works in the world. There were two sections of Silesia in which one encountered a number of works, some of which were, in a way, relics of the former mountain and forest industry. Saxony had a strongly developed glass industry. Dresden could boast of a number of glass factories. Then there was Thuringia, which was a strong centre. On the western borders of Bavaria, also, touching upon Czechoslovakia, one came across another glass centre; whilst in the Saar district there was a considerable glass industry. Similarly, in the district between Cologne and Essen there was a strongly developed industry, and a still further group of factories as one came into the neighbourhood of Aix-la-Chapelle. Out of about 350 factories which existed in Germany in 1924, not more than between 50 and 60 were concerned with glass bottle production. The largest group of factories was that known as the hollow-ware group, which was identified with the production of all kinds of domestic articles. The manufacture of window glass and plate glass was also more widely separated than in Britain. Chemical and scientific glassware was also produced in considerable volume, the Thuringian factories being particularly important from this particular aspect.

As regards raw materials, the German manufacturer might be said to be well supplied, although as regards fuel, supplies of hard coal were not so well distributed as in England. The Lausitz district, for instance, had depended almost entirely for its fuel supplies on the enormous beds of brown coal situated thereabouts. In respect to other raw materials, Germany was particularly fortunate.

German glass making had not undergone anything like such drastic changes since the war, as had been the case in England. In Germany sheet glass was still being produced by methods which did not involve continuous operation. The general expectance, however, seemed to be that within a year or two the hand production of sheet glass would be a negligible quantity. In the making of electric light bulbs, automatic equipment was only just being installed. In the bottle section, conservation was far deeper than in any other branch of the industry. The machines which had been developed were largely of the semi-automatic type.

It was noticeable that something had been done directly and definitely during the last four or five years to encourage research work in glass technology. In this connection such institutions might be mentioned as the one at Zweisel; a trade school in Bavaria in which technique played a part; the technical school at Karlsruhe in which, in 1923, there was set up a department of glass technology; the high school at Hanover, where there was a section devoted to glass and ceramics; and the department of silicates which was opened in May, 1926, at the Kaiser Wilhelm Institute in Berlin.

Developments in the Glass Industry in Russia. By PROFESSOR J. F. PONOMAREFF (Tomsk, Siberia).

One of the many difficulties encountered was the great distances which separated the various factories. Many works were run without having any technical or trained men in authority. The supplies of raw materials were good, there being plentiful deposits of sand and limestone. Sodium sulphate was obtained cheaply by evaporation from natural lakes. Sinse the revolution the number of glass factories had been reduced from 200 to 100; some 40,000 labourers were now employed. Stress was laid upon the need for attracting young educated men to help in the development of the glass industry in Russia. At the same time it was noteworthy that the simple worker could do excellent work, although he was uneducated.

Owing to lack of time the reading of the following paper was postponed :— *The Thermal Expansion of Some Boric Oxide Containing Glasses.* By PROFESSOR W. E. S. TURNER AND F. WINKS, M.Sc.Tech.

FARADAY SOCIETY.

The following paper was read at the Meeting held on January 26, 1927 :—

The Activation of Hydrogen in the Electric Discharge. By G. A. ELLIOTT, Ramsay Memorial Fellow. Communicated by Professor F. G. Donnan.

Numerous observations have been made recently of the formation by both electrical and chemical methods of abnormally active forms of hydrogen. The results of this work indicate the existence of two main varieties of active hydrogen. The first, monatomic hydrogen, was discovered by Langmuir, who immersed an electrically heated tungsten wire in hydrogen at pressures of not more than a few centimetres of mercury. The abnormal heat conductivity of the gas under such conditions was shown to be due to the dissociation of the hydrogen molecules. It was found that the resulting hydrogen atoms possessed many remarkable properties; they reduced sulphur, phosphorus, and arsenic to the corresponding hydrides at ordinary temperatures, were very readily adsorbed on surfaces and easily re-combined with evolution of heat to form diatomic hydrogen. For example, although the hydrogen atoms could be condensed at the temperature of liquid air, on warming, diatomic molecules only were evolved.

A second active modification of hydrogen is the triatomic variety whose existence was first clearly indicated by the work of J. J. Thomson. It would be reasonable to suppose that this substance is more readily formed at higher pressures than is monatomic hydrogen and, hence, it has been customary to refer to any active modification of hydrogen formed at pressures approaching atmospheric as triatomic hydrogen or "hyzone." Wendt first recorded the formation of active hydrogen at ordinary pressures. He obtained it by the action of α rays from radium emanation in pure hydrogen and, subsequently, by other methods. Wendt and his co-workers found that their active hydrogen possessed the following properties which distinguish it from monatomic hydrogen :—

It is not strongly adsorbed on surfaces, will survive passage through a plug of glass-wool and is formed at higher pressures. Also it may be condensed in and evaporated from liquid air without loss of activity. In addition they state that it spontaneously decomposes after a time interval of the order of one minute, while recent work by Bonhoeffer has shown that the half-life period of monatomic hydrogen is one-third of a second only.

GENERAL EXPERIMENTAL ARRANGEMENTS.

Pure hydrogen was prepared by the electrolysis between platinum electrodes of a solution of barium hydroxide. The cell was water-cooled and adequate arrangements were provided for the separation of the products of electrolysis. With this apparatus the maximum rate of production of hydrogen was approximately three litres per hour. The gas was purified by passage over anhydrous calcium chloride, hot platinised asbestos to remove oxygen, potash purified by fusion with a little potassium permanganate and, finally, over a layer four feet long, of pure phosphorus pentoxide. This purifying train was evacuated as completely as possible before filling with hydrogen and the apparatus was left in use for several days before commencing experiments. For qualitative work and where a rate of flow beyond the capacity of the electrolytic cell was required, electrolytic hydrogen from cylinder was utilised. The cylinder hydrogen was, however, passed through the above-mentioned purifying train before use.

The supply of direct current at high voltages for experiments with the wire-in-cylinder discharge tube, was obtained by rectifying the output from an induction coil used as a transformer. The primary circuit was fed with alternating current at 400 cycles per second. A Kenotron valve was used as rectifier and the pulsating current so obtained was smoothed by means of a suitable condenser and choke coils. This unit delivered a maximum line voltage of 70 volts.

For the ozoniser experiments the high tension alternating current was obtained from a transformer with a closed iron circuit or from a large induction coil used as a transformer. Two generators giving 80-200 volts at 400 and 85 cycles per second respectively supplied the requisits primary current. Intermediate frequencies were obtained by carying the speeds of rotation of these machines.

Electrical Measurements.—Voltages were measured by means of a Kelvin-White electrostatic voltmeter reading from 0 to 10 or 20 kilovolts, r.m.s. the voltmeter was connected directly between the two electrodes of the discharge tube.

When alternating potentials were used the power expended in the gas was

measured by a method involving the use of a wattmeter of dynomometer patters, which was connected in the primary circuit. The power developed in the discharge is given by the difference between the wattmeter readings when the discharge is passing through the gas and when, other arrangements being unaltered, the two electrodes of the discharge vessel are connected together and to the high voltage terminal of the transformer. It was necessary to make small corrections to the wattmeter readings for the copper losses in the transformer, since these vary with the load.

The principal frequency of the alternating current was calculated from the speed of rotation of the generator shaft, under the conditions of the experiment which was in progress, and from the number of poles in the alternator field. It must be understood that the frequency so determined is the fundamental frequency only. No appaıatus was available for the determination of wave forms.

The Properties and Life Period of Active Hydrogen.—It has been established that the active hydrogen which has been obtained is not appreciably destroyed by passage through a short plug of glass-wool. It is completely condensed in liquid air, but retains only about one-twentieth of its original activity after re-evaporation. A fine tungsten wire placed in the stream of active gas was not appreciably heated.

One further point of interest concerns the nature of the reaction between sulphur and active hydrogen. On examining the sulphur tube and adjacent tubing after long continued use, a deposit of finely-divided whitish sulphur could be seen just below the upper layers of crystalline sulphur, Traces of a similar white substance were also seen further along the tubing and especially at the point where the tubing, after leaving the discharge tube, first dips into the liquid air bath. This would appear to indicate that the action of active hydrogen on sulphur at ordinary temperatures results in the formation of an unstable and volatile polysulphide of hydrogen.

In conclusion, the outhor desires to express his thanks to the Ramsay Memorial Fellowship Trustees for a Fellowship, to Dr. R. W. Lunt for much valuable assistance at various stages in the development of this research and, also, to Professor F. G. Donnan, F.R.S., for his interest and instructive advice during its progress.

THE PHYSICAL SOCIETY.

The following paper was read at the Meeting held on Friday, December 10, 1926, at the Imperial College of Science; Professor O. W. Richardson, M.A., D.Sc., F.R.S., in the chair :—

Electrical Polarisation in Selenium Cells and the Effects of Dessication." By A. O. Rankine, D.Sc., Professor of Physics, and J. W. Avery, B.Sc., D.I.C., some time Research Student, Imperial College of Science and Technology. Communicated by Professor Rankine.

Abstract.

The paper describes measurements of the secondary E.M.F.'s displayed by selenium cells and the apparently abnormal effect of illumination on the corresponding secondary currents. Both are shown to be probably due to an invisible water film in parallel with the selenium. That this film is the principal seat of the polarisation seems to be proved by the fact that the polarisation disappears almost completely with prolonged drying. On this basis a satisfactory quantitative explanation of the various effects is given. An important practical consequence of the dessication of the cell is the large increase obtained in its sensitivity to light.

GEOLOGICAL SOCIETY OF LONDON.

At the meeting held on January 19, 1927, the following communications were read :—

The Geology of the Austral or Tubuai Islands (Southern Pacific). By Lawrence John Chubb, M.Sc. Communicated by the Secretary.

The Austral or Tubuai Group is situated about 350 miles south of Tahiti, and 1,800 miles noıth-east of New Zealand. It includes seven islands, of which four are here described.

Rapa is a crateriform island, the slopes of which have been deeply dissected by radial streams, while the ends of the spurs between the valleys have been carved into precipitous cliffs by the sea. After one of the radial streams had captured the drainage of the crater, the island was submerged, with the result that the river-valleys were embayed and the crater flooded. Subsequently, slight elevation occurred. The formation of cliffs has proceeded so far that the greatest heights are now around the coast, while the subaërial erosion has resulted in the formation of aiguilles. Small coral-reefs are developed in the bays.

Marotiri, at the south-eastern extremity

of the group, consists of a number of needle-like stacks rising out of the sea, and situated roughly on the circumference of a circle. Probably it represents the last stage of an island of the type of Rapa, which has subsided until all except the highest peaks are submerged.

Rurutu is without the sharp peaks and serrated ridges characteristic of Rapa, and the valley-mouths are not embayed. It is surrounded by an elevated coral-reef, rising to 200 or 300 feet above sea-level, which from its form appears to be of the fringing variety. This reef is unconformably related to the underlying rocks, and faces the sea in a line of vertical cliffs. At its summit there is a terrace behind which the hills of volcanic rock arise. Above a height of 600 feet these are deeply weathered to a red clay, and raised plateaux occur at different altitudes. The history of the island appears to be one of frequently-renewed ,intermittent elevation, stationary periods being indicated by the raised plateaux, and the different degrees of weathering of the rocks at different levels. In the later stages a fringing-reef came into existence which was finally uplifted. A narrow fringing-reef has developed around the island in recent times.

Rimatara is surrounded by a coral-reef about 2 miles wide. The outer edge of the central island is occupied by an elevated reef, which faces the sea in a line of cliffs 20 or 30 feet high.

The islands are arranged along lines having a general west-north-westerly and east-south-easterly trend, and it is suggested that the movements of elevation and subsidence which they have undergone may be due to the fact that they are situated on a submerged anticlinal fold, the crest of which has moved northwards.

The Petrography of the Austral or Tubuai Islands (Southern Pacific). By WALTER CAMPBELL SMITH, M.C., M.A., Sec.G.S., AND LAWRENCE JOHN CHUBB, M.Sc.; with Chemical Analyses by EDGAR DONALD MOUNTAIN, M.A.

Except for a few small local occurrences of pyroclastic rocks, the volcanic rocks of Rapa consist of phonolitic and basaltic lavas invaded by many dykes and other small intrusions. Of the latter the most interesting probably forms the plug in the vent of the main volcano. It is an extremely melanocratic olivine-theralite, richer at the same time in nepheline or in olivine than any hitherto recorded. It bears fairly close relationship to Tyrrell's kylite from Benbeoch, Dalmellington, and should probably be included in Lacroix's group of luscladite. Other interesting intrusions are a crinanite, almost identical with that which forms the Dippin Sill in South-Eastern Arran, and a kylite.

The lavas and smaller dykes appear to form a single series :—trachytoid phonolite, trachybasalt, basic andesine andesite, basic olivine-basalt, (and basalt with abundant phenocrysts of augite and olivine. The basic porphyritic basalts are the predominant lavas; they resemble the picritic basalts of Hawaii and the ankaramites (ultrabasic basalts) of Tahiti. All the acid and basic lavas compare very closely with rocks from Tahiti, while rocks comparable with the trachybasalt and the basic andesine andesite have been described from Hawaii.

In Rurutu occurs an olivine-bearing nepheline-tephrite, which resembles a rock described from Franklin Island (Antarctica). Otherwise the basic lavas found in this island are similar to those of Rapa.

Eight chemical analyses of the rocks are contributed by Mr. E. D. Mountain.

A general discussion followed.

SOCIETY OF PUBLIC ANALYSTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, February 2, Mr. E. Richards Bolton, President, being in the chair.

Certificates were read for the first time in favour of Messrs. William Gordon Carey, F.I.C.; William Farrand Elvidge, B.Sc., A.I.C.; Lewis Sidney Fraser, B.Sc., A.R.C.Sc., A.I.C.; Frederick Percival Hornby, B.Sc., A.I.C.; Gerald Roche Lynch, O.B.E., M.B., B.S., D.P.H.; Eric C. Martin; George Gilmour Philip.

Certificates were read for the second time in favour of Messrs. Solomon Greenberg, F.I.C.; Frank Crafer Ray, M.A., F.I.C.; and Geoffrey Charles Matthews, B.Sc., A.I.C.

Mr. Stanley Grove Burgess, B.Sc., A.I.C., was duly elected a Member of the Society.

The following papers were read and discussed :—

Arsenic in Printing Ink. By T. HEDLEY BARRY.

Most of the printing ink pigments contain arsenic, and it is possible to classify them into three groups on the basis of the amounts of arsenic present. It is shown that a limit of 1 part of arsenic in 50,000 of the ink pigment would satisfy the most stringent requirements of health authori-

ties, but this mode of expression is unsatisfactory, and it would be preferable to fix a limit of arsenic per unit area of the printed paper or wrapping.

The Immersion Refractometer and its Value in the Analysis of Milk. By G. D. Elsdon, B.Sc., F.I.C., and J. R. Stubbs, M.Sc., F.I.C.

In view of the importance which certain Police Courts, especially in the North of England, have attached to the application of the refractometric test in milk analysis, the authors have investigated the test. Part I. of the paper is an examination of the Zeiss Immersion Refractometer from the point of view of its use for milk. In Part II. experiments are quoted to show that the refraction of a milk serum apparently changes with two factors—the percentage of solids-not-fat and the acidity of the milk. The decreased refraction due to added water may be entirely masked by the souring of the milk; in fact up to 10 per cent. of added water might be entirely overlooked in this way.

Details are given of the examination of about one thousand mixed milks, and the results show that the average refraction for milk serum, when the copper sulphate method is used, is about 38.3 scale divisions in the case of commercially fresh milks. The conclusion is drawn that the method offers no advantage over the usual determinations, and that it has certain drawbacks peculiarly its own.

Irish Moss Mucilage and a Method for Its Determination. By Paul Haas, D.Sc., and Barbara Russell-Wells.

Irish moss or carrageen mucilage consists of a mixture of two ethereal sulphates. These can be determined by precipitation with benzidine chloride and titration of the washed precipitate with standard sodium hydroxide solution. Free sulphates, if present, are first precipitated by adding excess of barium chloride. The method can be used for the determination of carrageen mucilage in the presence of gelatin, gum arabic, agar-agar, and fruit pectins.

NOTICES OF BOOKS.

Studien zur Geschichte der Chemie. (Festgabe Edmund O. V. Lippmann.) Herausgegeben von Julius Ruska. Pp. 242, with a portrait. Berlin : Verlag Julius Springer. 1927. Price, 19 marks 50.

Professor Lippmann has made so many important contributions to the study of early chemistry and medicine that it is fitting for his *Festschrift*, ably edited by Prof. Ruska, should consist of a collection of interesting historical essays. Of these, three are in English. Mr. E. J. Holmyard adds further to our knowledge of the personality of Jâbir ibn Hayyân and incidentally mentions that M. Paul Geuthner has undertaken to publish the Arabian originals with English translations of all Jâbir's works. The significance of this can hardly be over-estimated, for Jâbir stands in relation to chemical science where Aristotle does to philosophy.

Professor Ruska himself also contributes an article on Jâbir's '*Book of 70*' referring to the titles, Latin translations, their whereabouts and the subject matter. He also refers to the accounts of them that have appeared in recent times by Berthelot and Darmstaedter.

In a study of early alchemy, A. J. Hopkins writes upon "Transmutation by Colour," and the other article in English, by Tenney L. Davis—"The Last Stand of Phlogiston"—deals with Priestley's writings in defence of the doctrine after his arrival in America. It is apparent that the discoverer of oxygen felt out of touch with science after he left England and naturally became more absorbed in theological matters.

Professors Zuretti and Mieli each communicate articles in Italian and the rest are in German. They include :— The Babylonian-Assyrian Lapis Lazuli, by Professor E. Darmstaedter; The Native Land of John the High Priest and Alchemist, by Professor O. Lagercrantz; Arabian Contributions to Mineralogy, by Dr. Wiedemann; History of the Development of Chemical Symbols, by Professor P. Walden; The Heat Substance and Oxygen, by Dr. E. Farber; Correspondence between Goethe and Wackenroder, by Dr. C. Brauer; Berzelius and Hwasser—a Page in Swedish Science, by Professor H. G. Söderbaum; and Early German Cement Manufacture, by Professor G. Bugge.

At the end there is a list of Professor Lippmann's books and works on the history of science and technology. These number 159, and include many of outstanding importance.

The *Festschrift* is one very fitting to the recipient, who has spent his life in elucidating many obscure parts of the development of chemical science.

J. G. F. D.

SCIENTIFIC BULLETINS ISSUED BY U.S. BUREAU OF STANDARDS.

No. 538.—*Spectral Energy Distribution of the Light Emitted by Plants and Animals*, by W. W. Coblentz and C. W. Hughes. 10 cents.

No. 536.—*Portable Radio Direction Finder for 90 to 7,700 Kilocycles.* By F. W. Dunmore. 10 cents.

No. 541.—*Review of the Literature Relating to the Critical Constants of Various Gases.* By S. F. Pickering. 15 cents.

Lecithin and Allied Substances. The Lipins. By Hugh Maclean, M.D., D.Sc., and Ida Smedley Maclean, D.Sc., F.I.C. Pp. VII. + 220. Price 10s. 6d. net. London : Longmans Green & Co., 39, Paternoster Row, London, E.C.

The present is a new edition of this useful monograph, which is an evidence that it has been pretty extensively read. The Lecithins, or fat-like substances obtained from tissues, both animal and vegetable by various solvents, seem to have caused some trouble among chemists to find for them a suitable designation. In this connection the word " lipoid," has been used rather freely. The authors of the present monograph suggest that " lipoid " be used to designate the ether soluble substances extracted from the tissues. They designate by the title of the present book two classes of fat-like bodies : (1) The phospholipins, or phosphotides; and (2) the galactolipins, or cerebrosides. It would be well if chemical terms could be standardised, for confusion is inevitable if various authors apply names of their own to substances that are more or less common. The subject is eminently one for the attention of some competent body with sufficient power to secure respect for its decision. The authors in the present instance have produced a useful and authoritative work and one which must have entailed a good deal of research. The importance of the book is enhanced by the extended bibliography which is given, and which will enable the reader to consult various authors who have dealt with some phase of the subject. There is also given a detailed alphabetical index.

CORRESPONDENCE.

A CATALYTIC CONDENSATION PRODUCT FROM ACETYLENE.

(*To the Editor of the* Chemical News.)

Sir,

Supplementing my letter which appeared in your issue for February 4, p. 75, relative to the formation of a solid condensation product of acetylene, Mr. G. W. Acheson, upon reference to my notes, calls my attention to the fact that the best results were obtained with the glass tube and the heat of an ordinary paper match.

I mention this to show that the intense heat of a blow torch is not necessary, being really detrimental, as the product so obtained is usually dark brown in colour, the shade being due, in all probability, to partial carbonization.

Raymond Szymanowitz.

Forest Avenue,
Caldwell,
New Jersey, U.S.A.

I am grateful for the valuable information given in the above correspondence. I am investigating the literature and hope to contribute something in supplementation to R. Szymanowitz's work.

F. H. Loring.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

Albemarle Street, London.

Thursdays, February 24, March 3, and 10.—" The Progress of Hittite Studies." By John Garstang, D.Sc., F.S.A. John Rankin, Prof. of Archæology, University of Liverpool.

Friday, February 25.— " The Solids of Plato and Archimedes." By D'Arcy W. Thompson, C.B., D.Litt., F.R.S., Professor of Natural History, University of St. Andrews.

Saturdays, February 26, March 5 and 12. —" Beethoven." By John B. McEwen, M.A., Mus.Doc., F.R.A.M., Principal of the Royal Academy of Music. (With Musical Illustrations.)

On March 26, 1827, Beethoven died at Vienna in the 57th year of his age. Apart from his artistic activities his life was almost devoid of incident, but it is doubtful if ever there has been any composer whose work has had such an influence on the progress and development of the Art of Music.

These three lectures will be given practically one hundred years after the composer's death, and will be devoted to an attempt to show to what extent and in what directions the Art has progressed under his influence. They will be illustrated by vocal and instrumental selections from his works, designed to show the peculiar features of the method and trend of thought which have made him perhaps the most compelling personality in the history of music.

ROYAL SOCIETY OF ARTS.

Monday, February 21, at 8 p.m.—(Cantor Lecture.) Professor Ernest George Coker, M.A., D.Sc., F.R.S., M.Inst.C.E.. Professor of Civil and Mechanical Engineering, University College, University of London : " Photo-elastic Measurements of Stress Distribution." (Lecture II.)

Wednesday, February 23, at 8 p.m.—(Ordinary Meeting.) Francis H. Carr, C.B.E., F.I.C., President of the Society of Chemical Industry : " Insulin and its Manufacture."

Monday, February 28, at 8 p.m. (Cantor Lecture). Professor Ernest George Coker, M.A., D.Sc., F.R.S., M.Inst.C.E., Professor of Civil and Mechanical Engineering, University College, University of London : " Photo-elastic Measurements of Stress Distribution." (Lecture III.)

UNIVERSITY OF LONDON.

University College, Gower Street, W.C.1.

Monday, February 21, at 5.30 p.m.—" Afrikaans Language and Literature." First of a course of two public Lectures by Mr. J. Haantjes. February 21 and 28. Chairman at the first lecture, The Provost, Sir Gregory Foster.

Tuesday, February 22nd, at 5.30 p.m.—" Cultural Anthropology." First of a course of four public lectures by Mr. W. J. Perry. February 22, March 1, 8 and 15.

Thursday, February 24, at 5.30 p.m.—" Physical Education and Sport in America." A public lecture by Dr. H. A. Harris.

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Wireless Section.—Monday, February 21, at 7 p.m.—" National Busbars of Central Europe." Discussion to be opened by Mr. R. O. Knapp.

Mersey and North Wales Section, University of Liverpool, Laboratories of Applied Electricity.—Monday, February 21, at 7 p.m.—J. H. Reyner, B.Sc. : " Recent Developments in Radio Reception."

North Midland Centre, Hotel Metropole, King Street, Leeds.—February 22, at 7 p.m.—Colonel E. Mercer : " Notes on the 60,000-volt Underground Network of the Union d'Electricité.

North-Western Centre, Manchester.—Tuesday, February 22, at 7.30 p.m., at the Manchester College of Technology, Professor W. M. Thornton, O.B.E., D.Sc., Faraday Lecture on "What is Electricity?"

THE LATE PROFESSOR TILDEN'S ESTATE.

Sir William Augustus Tilden, F.R.S., D.Sc., LL.D., F.I.C., F.C.S., of The Oaks, Murray Road, Northwood, formerly Professor at Mason College, Birmingham, and the Royal College of Science, who died on December 11, aged 84, left estate of the gross value of £6,461, with net personalty £3,315.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

2,556.—British Dyestuffs Corporation, Ltd.—Production of stable diazo compounds. January 28th.

2,312.—Espes, E.—Apparatus for detecting carbon-monoxide. January 26th.

2,299.—Geigy Akt.-Ges., J. R.—Dyestuffs. Jnauary 26th.

2,044.—I. G. Farbenindustrie Akt.-Ges.—Production of phosphorus. January 24th.

2,400.—Soc. Francaise de Catalyse Generalisee. — Catalytic production of methyl alcohol. January 27th.

Specifications Published.

255,406.—Carbide and Carbon Chemicals Corporation. — Glycol ethers and cellulose-ester solvents.

Abstract Published.

262,494.—Methyl alcohol.—Drefus, H., 8, Waterloo Place, London.

Methyl and higher alcohols; hydrocarbons.—Methyl alcohol is prepared by passing water gas, or other gas mixture containing carbon monoxide and hydrogen in equimolecular proportions, at elevated temperature and pressure over zinc oxide without admixture with other methyl-alcohol forming catalysts. The pressure employed may rise to 200 atmospheres, but is preferably of the order of 50-150 atmospheres; the temperature does not exceed 450° C., and is preferably kept between 200-300° C. According to the example, carbon monoxide is passed with its own volume, or a little less, of hydrogen at a pressure of 80-120 atmospheres over granules of zinc oxide or precipitated zinc oxide maintained at a temperature of 250-300° C.; the resulting methyl alcohol is condensed and the unreacted gases recirculated through the apparatus, which is preferably copper-lined or made of aluminium, etc. If the gases are passed through the apparatus at too low a speed, hydrocarbons and higher alcohols predominate.

Reference has been directed by the Comptroller to Specification 20488/13.

The Latest TRADE MARKS

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PUTENTEX.

473,545.—Chemical substances prepared for use in medicine and pharmacy. — Chemische Exportgesellschaft Vauka Mit Beschrankter Haftung, Eschersheimer Landstrasse 53 to 55, Frankfurt a/Maine, Germany. February 2nd.

474,756.—Circular chain device for chemical substances prepared for use in medicine and pharmacy.—Johnson & Johnson (Great Britain), Ltd., 106, Golden Lane, London, E.C.1., and Fairlie Road, Slough Estate, Slough, Buckinghamshire. February 2nd.
2nd.

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AN ATOMIC MODEL FOR THE CHEMIST.

By FLORENCE LANGWORTHY.

Next month will bring us the bi-centenary of Newton's death. In his case Time has brought its revenges, for although his corpuscular theory of light has suffered eclipse for a hundred years, yet the latest discoveries in physics are leading us back to that theory and away from the undulatory theory.

So the Bohr atom—now under a cloud—is not a satisfactory atom even for a physicist. According to this atom light is due to the jump of an electron from an outer orbit to an inner orbit. Thus not even an electron leaves the atom nor is there even a push given to that highly problematical substance, the ether, by the outward jump of an electron. We have reason for thinking that the universe, the solar system and the atom are modelled upon the same plan, but, in the Bohr atom, the sun, instead of giving out light, is simply a dumping-place for all the positives of the atom, while the planets—electrons merely—jump about in a strange fashion that we certainly do not see in our solar system. There is no stability about the planets in this atomic system. And even as the Bohr atom is thus unsatisfactory from the physicist's point of view, so it is from the chemist's point of view. An atom that presents to the outside world negatives (electrons) only is not the sort of atom that a chemist find acceptable when he has to account for the linkings-up of chemistry. He may well expect his negatives and positives to be in direct contact and not to have a lot of electrons in between. The atomic weights, also, indicate "two" as the unit that is used in the building up of the atom, but our physicists have, in effect, taken the neutral hydrogen atom (A. W. 1.0077) as the unit and tell us that the fraction has disappeared from the weight of the helium atom (A. W. 4.0) because of the squeezing to which the atom has been subjected. But the atomic unit—and Moseley showed us that there is such a unit—can be two quite as easily as one and a lost fraction, and since the atomic weights undoubtedly point to two, it is surely better to follow this lead before trying to believe anything so incredible as that matter can be squeezed out of existence. The chemist's experience of matter is that it is well able to take care of itself.

The evidence in favour of this "two" unit I briefly gave in a recent article (*Chem. News*, January 14, 1927, p. 20), but for those who did not read it, I quote the following:— "The unit by which the atom increases in weight appears to be two, save for the monatomic gases where four is added. After helium 4 comes lithium, which has two isotopes, 6 and 7. In lithium^6 we will suppose that we have the undamaged atom. If the atom is damaged then the isotopes may be either higher in weight—should the atom be repaired—or lower, if for any reason it is not repaired. The next element, beryllium, gives us the damaged atom only, beryllium^9. But with boron we get boron^{10} and boron^{11}. Carbon yields only the undamaged carbon^{12}, nitro-

gen, the undamaged nitrogen^{14}, and oxygen, the undamaged oxygen^{16}. With fluorine we get only the undamaged florine^{19}, but if we add to the undamaged fluorine^{18} the four needed for the monatomic gas, neon, we have the two isotopes of the latter, 20 and 22. This reckoning by twos and fours will bring us to the exact weight of titanium, 48, an element that has no isotopes. The *first* extra positive appears to come into the atom with selenium. There is a rise in weight from arsenic 74.98 to selenium 79.2. If we look upon arsenic^{74} as undamaged arsenic then we shall have selenium^{76} and selenium^{78} for the undamaged twin-element. The damaged element will have isotopes both higher and lower than these. The next twin-element seems to be cadmium. There is a rise in weight from silver 107.88 to cadmium 112.4. The weight of silver points to 108 and this would give us a cadmium^{110} and a cadmium^{112} for the undamaged twin-element. Cadmium^{112} is followed by indium 114 and then there is another rise to tin 118.7. So we apparently have another twin-element, a tin^{116} and a twin^{118}. One of the isotopes of tin is a tin^{116}. After tin comes the damaged antimony 121.77 and then there is another jump to tellurium 127.5. The undamaged antimony would be 120 so the undamaged tellurium twin-element should contain a tellurium^{122} and a tellurium^{124}. The element iodine, which follows, has the weight of 126.92, indicating that the undamaged iodine has the expected weight of 126 so the excess in weight of tellurium is evidently due to something abnormal. With selenium and tellurium as twin-elements we shall expect to find holmium the same, but there is not this rise in weight from dysprosium to holmium. This would seem to indicate that in holmium one of the twins has disappeared and that there is a holmium (undamaged) still to be found. The remaining twin-elements appear to be mercury, lead, polonium, radium, thorium and uranium."

The above was also written as an attempt to explain why the atom grows more positive, as a whole, as it increases in weight. For though it grows more negative as it progresses from lithium to oxygen, yet if we consider the elements ranged under oxygen in the Periodic Table we shall find that chromium, for instance, is more positive than sulphur, while selenium is more positive than chromium. Thus the atom can, apparently, at certain stages hold up an extra positive and the atomic weight seems to indicate these stages.

With the whole Periodic Table thus pointing to "two," is looks as if our physicists would have done better to have taken the negative hydrogen atom with two electrons for their unit rather than the neutral hydrogen atom with one. For one could argue that if the neutral or positive hydrogen atom with its one electron has the weight of one and the negative hydrogen atom with its two electrons has the weight of two, then hydrogen, as a whole, may well have a fraction in its weight. There are, for instance, two silicons, silicon^{28} and silicon^{29}, and the mixture of the two gives us the weight of silicon as 28.3.

But it will be protested that no one imagines that electrons are responsible for the weight of hydrogen. I venture to think, however, that weight is due to the pull of an electron upon a positive. Needless to say that this does not imply that whenever electrons leave an atom, weight is lost. We must distinguish between free electrons and those that are pulling upon positives. It is not to be doubted that the electron, taken by itself, is of the infinitesimal weight assigned to it, but when we come to the positive (the proton) we shall find that the difficulty is to take it by itself. It might be thought that since the hydrogen atom with two electrons is negative and the hydrogen atom with one electron is neutral then we have only to find the hydrogen atom with no electrons to secure the positive atom, *but this does not follow*, for the hydrogen atom with one electron at a greater distance than in the neutral atom, as, for instance, in Hydrogen A, is positive also. It looks, therefore, as if it is the proximity of the electron to the nucleus that makes the atom neutral and that, if the distance of the electron from the nucleus is far enough to permit of a negative's coming between, then that hydrogen atom is positive. In the molecule of water vapour we have one negative oxygen atom and two positive hydrogen atoms, not positive nuclei merely. The oxygen atom has apparently been able to get in between each positive nucleus and its electron. The latter, it would seem, have been repelled to such a distance that each hydrogen atom is now positive instead of neutral. This repulsion of the electrons by the oxygen atom might account for the heat of the combination, but the electrons, distant

though they are, are still constant to their nuclei.

The hydrogen atom, therefore, can appear as a positive even if it has an electron attached to it provided that this electron is at a very great distance from it—comparatively. This being the case, how are we to put any faith in the so-called weight of the *proton?* All we can be sure of is that if the proton does for a moment lose its electron then it will in its highly-ionised condition, speedily attract another. Sir Oliver Lodge writes. "We know that the proton weight just about the same as one atom of hydrogen." We cannot, therefore, judge by weight. It would not do to deduct the infinitesimal weight of the electron from the weight of the hydrogen atom and say that the remainder is the weight of the proton. For the proton may not—when really by itself—have a greater weight than the electron. I venture to think that my model of the atom will show that there is good reason for believing that atomic weight is due to strain in the relation of the positive to its electron—that it arises when something keeps them separated. It is as if we had stretched a piece of elastic.

Seeing that even in the neutral hydrogen atom the electron has to remain at a vast distance, comparatively, from the nucleus we may well suspect that there is another negative in the nucleus that is, by its repulsion, keeping it from its positive. In the *Chemical News* of January 14, 1927, I pictured the little negative particles that may be thrown off as the negative violet rays by excited atoms. Let us now picture two of these particles as being attracted towards a positive particle—one that has lost its two electrons and so is in an ionised condition. Attracted by the electrons of the nearer negative the positive revolves about it, but even as it does so the other negative is drawn too near to the little combination by the excited positive and so has its electrons repelled away from it to some distance by the inner electrons. We now have an atom in which we have two positives divided from the electrons that formerly made them two negatives. For the negative that was at the centre now has two revolving positives pulling its electrons away from it. And the outer of these two positives has its two electrons kept at a great distance from it by the repulsion of the inner electrons. We thus have four electrons separated from two positives and pulling upon them. We will suppose this is an atom of green helium with the atomic weight of four. It is green, we will say, because those two outermost whirling electrons allow all the red rays to pass through but repel all the green. (When electrons are to the fore we see green so that is the negative colour as opposed to the positive, red.) But suppose these two outer electrons should capture a positive. Then red rays will be reflected as well as green and our green helium would become yellow helium. And not only would it become yellow but it would become neutral. In our atom of green helium there were four electrons to three positives, but two of these electrons were at such a distance that the atom was a double-positive to any atom that could come between itself and its distant electrons. And this any negative atom could do since a negative atom has one or more positives within it whereas an electron is a pure negative. Even so we have pictured the oxygen atom as coming between the hydrogen nucleus and its distant electron. But when the two outer electrons of the helium atom capture a positive they, too, will be able to move inwards towards the nucleus seeing that they will now have a positive wherewith to placate the inner electrons of the nucleus. And as there will be now four positives to four electrons this atom of yellow helium will be neutral. The atom of green helium described above is also neutral in so far that it does not combine with other atoms, but as its electrons are at such a distance from its nucleus it has the chance, apparently, of *swallowing* other atoms and so transforming itself into another atom. Let us picture, for instance, a negative particle as being attracted to the double-positive. It can pass the two distant electrons and make its approach to the double-positive since it has a positive body in addition to its two electrons. But even as comets experience both attraction and repulsion from the sun, so this little comet-atom finds to its cost that a double-positive is not altogether what it seems and that it is dangerous to go too near to it. For a double-positive must contain a negative, and the two electrons of the latter may well be roused to repulsion by too close an approach on the part of other electrons. The comet-atom is unable to adapt itself to this combined attraction and repulsion since it now has on the outside of it those distant revolving electrons, which we will call electron-planets. It has managed to

pass these only to find itself trapped by them and driven by their repulsion so near to the sun-nucleus that its electrons are shot away from it. These cannot, however, be repelled past the electron-planets for they are electrons merely and have no positive body, and so they take up their position as the first pair of coronal electrons. Being deprived of its electrons, the comet-atom becomes positive and since no more positives can be tolerated there—and there is a double-positive to repel it—it is ejected by the positives in possession. It is repelled far beyond the electron-planets before the pull of its electrons is able to cope with the energy of that repulsion, then it is pulled into position and starts on its orbit. The atom thus has another positive which has been separated from its electrons to add to its weight. As it is a newly-ionised positive it will speedily attract a negative particle to itself. The latter will be able to keep its electrons in to itself; seeing that the positive is only a single positive, not a double; this negative, therefore, will not add to the weight of the atom. Here, then, we shall have a green (negative) lithium atom—the undamaged atom—of atomic weight six. When it is damaged and loses one of its coronal electrons, the sun-atom will "occlude" another particle the positive of which will be thrown to the negative planet—which will thus have an isotope—while the two electrons will be repelled to the lithium coronal orbit where they will take up their positions within the remaining one. Thus the atomic weight which had fallen to five will rise to seven and the atom will be red (positive) lithium.

But before the lithium atom is damaged and while the sun-atom is still in a highly excited condition the latter attracts another negative particle. Again the same process is gone through. Its electrons, however, cannot be repelled so far as were the first pair of coronal electrons, owing to the presence of the latter, so the orbits of this second pair are nearer to the sun-atom, they therefore have smaller orbits (higher frequency). The ejected positive body is also nearer to the sun-atom than was the former. This new positive planet then attracts a negative particle as did its predecessor and the positivism of the sun-atom is thereby still further modified. That is to say negative beryllium is more negative than negative lithium. It may be objected that the positive planet should counterbalance the negative particle but we must bear in mind that the positive planet has its electrons although it is separated from them. In this way, then, we can picture the atom as passing from lithium to beryllium, from beryllium to boron, from boron to carbon, from carbon to nitrogen and from nitrogen to oxygen. Not only is the atomic weight now sixteen but the oxygen planet is so near—comparatively—to the sun-nucleus that the next positive that is ejected falls, perforce, to the share of the electron-planets. This makes the atom fluorine (18) and gives it its first minor planet. But as a result of this sudden change the erstwhile electron-planets cannot now force upon the sun-nucleus the negative atom which it has attracted; their negativism is modified by the gift of a positive body. So the next intruding negative is not dismembered, but remains in the sun-region just as it is. The state of affairs, therefore, is that the sun-atom has been rendered neutral and put out of action; it has been changed from a green helium atom into an atom of yellow, inactive, helium, and, in addition, there is an unused negative in the sun-region. To this negative particle a positive is attracted and the excited positive, in its turn, attracts another negative particle with the result that the electrons of the latter are shot away from it to become electron-planets, while its positive body is left to perform its orbit as the second of a double-charge of positivism. The new sun-atom of atomic weight four brings the weight up to twenty-two and is now ready to build up another system of planets.

We thus have two sun-atoms opposed to each other. Let us look upon these two sun-atoms as forming the two poles of the atomic sun. One of them will be active, and is the sun-atom of a system that at first is positive in comparison to what it will become. The other is inactive and is the member of a decidedly negative system. Before the advent of the second sun-atom the planets would have had circular orbits, but now that the centre has been split into two they will have to compromise. From the circle we have passed to the ellipse.

To turn from our little atomic sun to our little atomic system, the lithium planet will represent an undiscovered planet beyond Neptune, the beryllium planet will represent Neptune; the boron planet, Uranus;

the carbon planet, Saturn; the nitrogen planet, Jupiter; the oxygen planet will represent the missing planet where the asteroids are now. The fluorine planet will represent the first of the minor planets, Mars.

The first major planet thrown out by the new sun-atom will be the sodium planet (24). The first planet of a new system, it will be repelled as far as the lithium planet and we will picture it as being drawn too near to the same by the attraction of the negative, only to be repelled by the positive planet into an orbit. And soon a negative is attracted to it also. Thus the lithium planet—revolving about the atomic sun—will have this other planet, the sodium planet with its negative revolving about it even as we see the satellites of Jupiter, Saturn, etc., revolving about them.

But although the first major planet of the second system will be able to revolve thus about the lithium planet, its coronal electrons will not be able to take their place beside the coronal electrons of the lithium planet. They will be forced by the negative repulsion to take up orbits within the orbits of the coronal electrons of the fluorine planet. The new electron-planets and the coronal electrons will be acting upon them. Thus each new sun-atom will have planets of a higher frequency than those of the last. And thus the nucleus will be forced to become smaller and smaller. But in other respects the sodium planet will be like the lithium planet. It will be the first planet of a new sun-atom, and it will be thrown to an orbit as distant as the lithium planet, about which it will revolve. So we shall not be surprised to find that the lithium atom and the sodium atom resemble each other to such a degree as to lead to their being placed in the same group. The sodium atom, we may say, is the lithium atom plus the first system.

Each of our planets will have, as it were, a certain potential energy in virtue of its position. The repulsion of the electrons in the first sun-atom, for instance, for the coronal electrons of the lithium planet is such that it would send them flying from the atom but for their being kept in position by the repulsion of the electron-planets. And this repulsion is intensified in the case of the coronal electrons of the beryllium planet since they are nearer still to the electrons in the sun-atom. Still nearer and nearer, too, are those of the succeeding planets.

THE ACTION OF ELECTROLYSIS.

By Robert Saxon, B.Sc., F.C.S.
(Member of the Society of Chemical Industry.)

A lump of pyrites is taken weighing 17.280 grams, and is not pulverised so that its loss in weight can be easily found. It is placed in an electrolyte consisting of water saturated with ammonium chloride to which is added 15 per cent. of ammonium sulphate. It is to be noted that the former dissolves with reduction, the latter elevation of temperature. The author finds that the presence of either retards the solution of the other. As electrolysis proceeds both salts in solution are precipitated, to a small extent, much more noticeable round the anode when in a porous cell. As the presence of hydrochloric acid retards solution, that body forming is responsible for the reaction. After 3 hours' running under and touching a carbon cathode a cloud of copper sulphide comes off, the iro alone is dissolved, the lump weight 17.153 grams, after 6 hours 16.950 grams. Approximately half of this loss (0.330 grams) is CuS. A lump weighing 16.950 grams is placed under the anode and in 2 hours weigh 16.950 grams, 4 hours 16.735 grams, 6 hours 16.630 grams. The impurities give no loss when treated with dilute acids and no efferves cence. During electrolysis hydrogen, hydrogen sulphide, and chlorine are given off. The latter is arranged for as the electrodes are carbon.

The fact is that iron alone passes into solution as the sulphate (green), the copper is most likely on the negative side *copper pyrites is a cuprosulphide of iron.* There is no evidence to show that the copper passes into solution, even with porous pot away from the hydrogen sulphide, as whenever ammonium salts are used as electrolytes to separate copper there is always the blue coloration where the metal is separated. Such is not the case in these experiments.

DURABILITY OF CEMENT DRAIN AND TILE AND CONCRETE IN ALKALI SOILS: FOURTH PROGRESS REPORT (1923).

By G. M. Willams and Irving Furlong.

An interesting technological paper on the above subject has been issued by the U.S.A Bureau of Standards.

Summary of Results.

1. Drain Tile.

But little progress in the alkali attack since 1919, as recorded in B.S. Technologic Paper No. 214, has been observed during the 1923 inspection. Regional operations involving extensive irrigation and adequate drainage at many of the experimental drain sites have tended to reduce the severity of local exposure conditions.

Durability of cement drain tile for any given concentration appears to vary with richness of mix and consistency. Hand-tamped tile are less resistent to action than machine-made tile made of the same mortars.

Tile made with sufficient mixing water to result in such a consistentency that they must be retained in the molds for several hours have been proved more durable than richer mix tile of the machine-made type of such a dry consistency that the jacket may be stripped immediately. Results to date have indicated the 1915 replacement tile (series 19 and 20), made with a combination packing and tamping machine of a consistency permitting immediate removal of the jackel, to be more resistant to alkali action than richer mixes of the same consistency made on the packer-head type of machine or by hand. As a class it may be said that wet-tile have been much less affected by alkali action than dry-mix tile.

Inspection of drain tile and concrete structures in other localities where the alkali salts are of the chloride or carbonate types seem to justify the conclusion that these waters are not so severe as waters of the sulphate type which are found in all our drains in the alkali districts. Results have shown that it is impossible to estimate the maximum concentrations to which tile in the drain may be exposed by analyses of water flowing in the drain. In waters of the sulphate type severity of action appears to vary with the concentration of soluble salts. The number of types of tile affected by alkali varies roughly with concentration of water as determined by analyses of water samples taken at the outlet. In all cases where disintergration of the best quality of tile has occurred samples of the soil immediately in contact with such tile have revealed concentrations much higher than are indicated by the drain water.

To date, one or more marked cases of disintegration have been noted in every type of tile except series 19 and 20. The fact that appreciable quantities of salt have been found in the walls of this type in some cases would indicate that this type has probably not been exposed to the extreme concentrations found for some of the test specimens of series 2, 17, and 18.

Concrete Blocks.

The concrete blocks have all been exposed to waters of the sulphate type. Owing to variation and change in ground water conditions at some of the sites, some of the blocks have not been exposed to the extreme conditions which might be indicated by analyses of surrounding soils. While the Denver A series blocks have generally been more resistant to alkali than the blocks moulded on the projects, these blocks have been seriously affected where concentrations have been high.

As in the case of drain tile, it may be stated that severity of action on the concrete blocks appears to vary with concentration of soluble salts. While there is no record of the maximum concentrations encountered, conditions have been such on one project that all blocks installed may be considered as complete failures.

With the same aggregates, lean mixtures are more seriously and rapidly affected than rich mixtures. Durability appears to be dependent upon impermeability, which is mainly dependent upon richness of mix and gradation of aggregate.

Conclusions.

While any conclusions drawn from the results of the investigation to date must be considered as tentative, it is believed that the scope of the work, the variety and types of concretes included, together with the widely different exposure conditions, have resulted in extending the knowledge of what occurs when such material is exposed to alkali soils and waters. No doubt further extension of this investigation, as well as independent investigation by others who are interested in the use of concrete under such conditions, will result in more detailed conclusions and accurate limitations, but the work to date has consistently emphasised certain precautions which should be observed by anyone using cement under such conditions.

Concrete Blocks.

1. Results to date indicate that materials of good quality and proper workmanship are of great importance in the production of concrete which is to be exposed to alkali soils and waters.

2. Action noted on surfaces of concrete blocks of best quality after one year exposure in sulphate waters has in most cases been progressive, depending upon conditions of exposure.

3. Extent and rapidity of disintegration in sulphate waters depends upon concentration of salts in waters to which the concrete is exposed.

4. In blocks containing reinforcing rods disintegration appears to be aided and accelerated in some cases by corrosion of embedded steel and consequent cracking of the concrete, as has been observed in some reinforced concrete structures exposed to sea water.

5. Structures placed in alkaline soils or exposed to alkaline seepage waters should be given all possible protection by drainage.

6. Seepage waters and alkaline soil conditions may be encountered which will disintegrate concrete of the best quality, and proper consideration should be given to soil and water conditions and protection by drainage and other means when it is proposed to expose concrete structures to conditions similar to those in which these test blocks have been placed.

7. Alkali salts are not uniformly distributed throughout the soil or large bodies of seepage waters, and it will be difficult to determine in advance the concentrations to which a structure may later be exposed. A systematic scheme for sampling soils will furnish information as to the quantities and types of salts available for solution, while analyses of seepage waters will indicate the concentrations present at the time of sampling. Disintegration is brought about only by those salts which are in solution as indicated by analyses of water samples, while the soil analyses merely represent reserve supplies which may bring about changes in the existing solutions with changing conditions of rainfall, flooding ,etc. The problem of drawing conclusions as to the most severe conditions which may occur becomes more difficult when the source of supply of the sâlt is through underground seepage from some distant point.

8. For the same concentration of soluble salts and for the same aggregates resistance of mass concrete to alkali action appears to vary with cement content or richness of mix, within the limits employed in these tests.

General Notes.

BUYERS MOBILISING.

Buyers in 34 countries abroad have made known their intention of visiting the British Industries Fair which opened simultaneously in London and Birmingham last Monday (February 21). They are coming from every country in Europe, the Dominions, the Argentine, Chile, Iceland and even China. The United States and Holland will probably be among the countries most represented. In the next few weeks fairs will be held in Leipzig, Prague, Vienna and Basle, and buyers visiting them can see the British Fair first.

ELEVENTH EXPOSITION OF CHEMICAL INDUSTRIES. (NEW YORK.)

The coming Eleventh Annual Exposition of Chemical Industries to be held in the Grand Central Palace, New York City, September 26 to October 1, inclusive., 1927, is one of the outstanding features of industry for this year. Plans are progressing rapidly and the indications are that many new and interesting features will be exhibited.

The value of such expositions have been evidenced by the record attendance in the past, thereby establishing the fact that the Allied Chemical Industries are. of vital importance to the entire business world.

This year the program of the Students' Course, conducted by and in charge of Professor W. T.Read , Texas Technological College, will be divided into two sections. The first will be the elementary students course and the second, an advanced course. As in the past, rigid tests and records of the students' work will be kept and forwarded to the institution from which the student registers.

Prominent among the features will be the following :—The southern section by states and railroads and showing the raw materials and opportunities of the Southern States; the Canadian Section by provinces and railroads to show the raw materials of Canada suitable for industrial development; the container section, exhibiting containers used in industry with the machinery for packaging, bottling, and labelling; and a laboratory supply and

equipment section. The sectional exhibits will be supplemented by displays of chemical products, machinery used is manufacture and development, dyes and fine chemicals, as well as instruments of precision, unit processes developed and in operation.

These exhibits are supported by a programme now being developed by a strong Advisory Committee.

CANADIAN HYDRO-ELECTRIC DEVELOPMENTS IN 1926.

The Dominion Water Power and Reclamation Service has prepared a bulletin giving a review of hydro-electric and water power development in Canada during 1926, which shows that year to have been one of widespread activity in this important industry. Approximately 266,000 horsepower was added during the year, bringing the total installation in the Dominion to 4,556,000 horse-power. The most important work of the year was that accomplished by the Gatineau Power Company in Quebec, in the virtual completion of two plants on the Gatineau River and the initiation of construction on a third, these three plants having a total designed capacity of 530,000 horse-power.

DIVIDENDS FROM B.C. MINES OVER $9,000,000 in 1926.

Public mining companies in British Columbia declared dividends of $9,051,645 in 1926, compared with $6,072,465 in 1925. The total dividends paid to date by these companies amount to $50,525,187. Dividends of private companies are not given, but would add considerably to the total. The Consolidated Mining and Smelting Company, Ltd., leads all Canadian mining companies in the amount of dividends declared for the year, with $5,070,120. The Premier Gold Mining Company declared dividends of $1,600,375, and the Howe Sound Company $1,587,260.

NORTHERN ONTARIO MINES.

$12,000,000 Disbursed in Dividends in 1926.

The gold and silver mines of Northern Ontario disbursed almost $12,000,000 in dividends to shareholders in the calendar year 1926, according to the Toronto Bureau of the Montreal *Financial Times*. The actual total, at $11,699,145, represents an increase of more than a million and a half dollars over the previous year. The Porcupine district gold mines disbursed $7,615,668 in 1926, compared with $7,083,468 in 1925. Kirkland Lake gold mines paid $2,368,464 in 1926, against $1,150,000 in 1925. The dividends paid by the silver camps show a slight falling off at $1,715,013 compared with $1,887,506 in the previous year.

OUTPUT OF CANADIAN COAL MINES UP 18 PER CENT.

Canadian coal mines produced 18 per cent. more coal in 1926 than in 1925 according to production figures now available. In 1926 the output was 16,105,000 tons, compared with 13,134,968 tons in the previous year. The 1926 production was distributed as follows : Nova Scotia, 6,180,000 tons; Alberta 6,117,000 tons; British Columbia, 2,634,000 tons; Saskatchewan, 376,000 tons; New Brunswick, 168,000 tons.

During the calendar year of 1926, Canada's total importation of coal amounted to 17,520,000 tons, and her total exportation was about 900,000 tons. Of the total imports 17,120,000 tons came from the United States, and the remaining 400,000 tons from Great Britain, Germany and the Netherlands. Total coal made available for consumption during the year, according to the Dominion Bureau of Statistics, was 32,725,000 tons.

WORM-KILLER WANTED.

His Majesty's Consul-General at Philadelphia (Mr. F. Watson, O.B.E.) reports that a Pittsburgh seed store wishes to be placed in touch with United Kingdom suppliers of a good worm killer for use in connection with golf links.

Firms desirous of offering material of British manufacture can obtain further particulars of the enquiry on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Reference BBX. 3234 should be quoted.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on February 3 :—

Studies upon Catalytic Combustion. Part V—The Union of Carbonic Oxide and other Gases with Oxygen in Contact with a Fireclay Surface at 500° C. By W. A. BONE, F.R.S., AND A. FORSHAW.

Experiments are described in regard to the action of a fireclay surface in catalysing the combustion of carbonic oxide and other gases at 500°, which lead to the following conclusions :—

(1) That the surface catalyses the combination of (moist) carbonic oxide and oxygen much in the same way as it does that of hydrogen and oxygen at the same temperature, though in a less degree.

(2) That, with a moist mixture of the carbonic oxide and oxygen in their combining proportions, the rate of combination is a lways directly proportional to the pressure of the dry mixture, provided that the surface is in a " normal " condition, and the reaction product quickly removed from the system.

(3) That the catalysing power of the surface can be greatly stimulated by previous exposure at the reaction temperature to the combustible gas. The stimulus so imparted is not, however, permanent, but gradually died away after the exciting cause is removed. It may also be removed by exposing the surface to oxygen at the reaction temperature. Indeed, an oxygen-treated surface becomes either "normally" active or only slightly more so, according to conditions.

(4) That when the carbonic oxide and oxygen are present in other than their combining proportions, their rate of combination is proportional to the partial pressure of the carbonic oxide, which thus becomes the controlling factor in the process.

(5) That of hydrogen, carbonic oxide, and methane, the first-named is the most, and the last-named the least, amenable to the catalytic combustion.

Experiments to Test the Possibility of Transmutation by Electronic Bombardment. By M. W. GARRETT. Communicated by F .A. Lindemann, F.R.S.

An attempt to transmute tin into indium, in a quartz apparatus similar to that used in the case of mercury (described in a previous paper), and similar to the apparatus in which Smits reported evidence of the formation of thallium and mercury from lead, proved a failure, in spite of the employment of high current densities and the extraordinary sensitiveness of the spectroscopic method. Indium was detected in all the samples of " pure " tin examined, though in barely detectable traces in the purest tin of C. A. F. Kahlbaum. The 4102 line was found to be the most persistent in the spectrum of this element (de Gramont lists 4511).

Attempts were made to prepare scandium from titanium, using electrons of sufficient speed to be certain of penetrating the K ring of this element. Titanium was bombarded with 12,000-volt electrons from a hot filament in an evacuated bulb, but no evidence of any transmutation was obtained.

The Theoretical Prediction of the Physical Properties or Many-Electron Atoms and Ions. Mole Refraction, Dimagnetic Susceptibility, and Extension in Space. By L. PAPLING. Communicated by A. Sommerfeld, For.Mem.R.S.

The general method followed in this paper is capable of refinements which should make possible the accurate prediction of the properties of any atom or ion. The most obvious one is the use of the wave mechanics in determining the state of an electron under the influence of a positive nucleus and several idealised electron shells. Explicit expressions for the properties of an electron in such a state may then be derived, eliminating the necessity of the more or less inaccurate adaptation of the equations obtained for hydrogen-like atoms. Further progress may also be made in approximating an electron shell more closely than is possible with a spherical surface charge. All of these refinements will greatly complicate the treatment, however; and while without doubt they will sooner or later be introduced, the relatively simple, if less exact, procedure which we have to provide approximate values of the physical properties of ions which may not exist under conditions permitting experimental investigation. The usefulness of these values in the consideration of the structure of molecules and of crystals will be illustrated elsewhere.

THE CHEMICAL SOCIETY.

The following papers were read at the meeting on Thursday, February 17 :—

The Production of Fog in the Neutralisation of Alkali with Hydrogen Halides. By H. O. Askew.

Air carrying carbonyl chloride vapour after passage through charcoal and an alkaline absorbing medium sometimes gave rise to a fog over the solution. This phenomenon has been traced to hydrolysis of the carbonyl chloride by adsorbed moisture, the hydrogen chloride thus produced being incompletely absorbed by the alkali and condensing to form a fog. Phosphorus oxychloride behaved in a similar manner.

The absorption of hydrogen chloride in alkaline solutions was then studied. In aqueous solutions, whether simple or containing colloids, dyes, or suspended solids, in general the wider the jet, the shallower the liquid, and the faster the gas was bubbled through the solutions, the greater was the amount of fog formed.

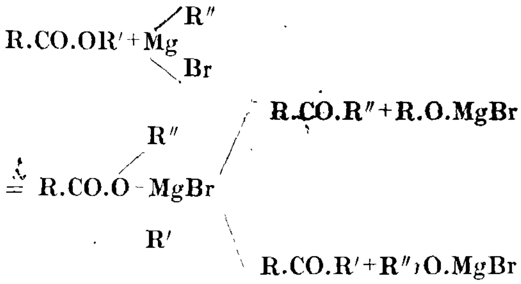
The concentration of acid in the fog particles and the partial pressure of the water vapour in the gas remained practically constant, and independent of the amount of for formed. With alcoholic solutions the acid concentration in the droplets decreased with increase in conentration of alohol. Pyridine solutions gave intense fogs. Hydrogen bromide was more active in fog formation than hydrogen chloride. In no case was any fog obtained after neutralisation of the alkali. The fog particles were larger when small amounts were formed. No electrical charges have been found on the particles.

It is suggested that the alkaline film slows down very greatly the rate of absorption of the acid vapour, this being intensified by the added dyes, etc. This film, however, very readily permits diffusion of water vapour into the bubbles of gas.

The Mechanism of the Reaction Between a Carboxylic Ester and a Grignard Reagent. By D. R. Boyd and H. H. Hatt.

In connection with investigations on derivatives of the triaryl carbinols, which have been in progress for some time, the authors have had frequent occasion to employ the Grignard reaction for the preparation of tertiary alcohols from ethereal salts, and have found that if the ester is caused to react with the Grignard reagent in the presence of metallic magnesium the products of the reaction include a pinacone as well as a tertiary alcohol. The bearing of this observation upon the mechanism of the ester-tertiary alcohol reaction is considered; it is concluded that a ketone is formed as an intermediate step in the production of a tertiary alcohol from an ethereal salt. The process by which the ketone arises is also discussed.

The authors criticise the hypothesis of Stadnikoff :—



and show that same of his conclusions are incorrect.

The reaction between an ester and a Grignard reagent in the presence of metallic magnesium forms an advantageous method for the preparation of pinacones in certain cases. With ethyl-ortho toluate and magnesium phenyl bromide the yield of pinacone was 38 per cent, the yield of tertiary alcohol obtained at the same time being 23 per cent.

Constituents of Myoporum laetum, Forst. (The "Ngaio"), Part II. Hydrogenation of Ngaione and Ngaiol, and Dehydration of Ngaiol. By F. H. McDowall.

In Part I. the author characterised the new ketone, ngaione, $C_{15}H_{22}O_3$, from the essential oil of the "ngaio" tree, as an open-chain di-olefinic compound containing two internal oxide linkings.

The presence of two double linkings has now been confirmed by the process of hydrogenation. Both ngaione and ngaiol take up four atoms of hydrogen to form the tetrahydro - derivatives, $C_{15}H_{26}O_3$, and $C_{15}H_{28}O_3$, which are then saturated.

A description was given of the action of various dehydrating agents on ngaiol. Formic acid gives a 50 per cent. yield of ngaiol formate. With potassium hydrogen sulphate ngaiol lost a molecule of water to form dehydrongaiene dioxide, $C_{15}H_{23}O_2$, but the yield was not large. Dilute sulphuric acid at the b.p. caused only a slight amount of dehydration whilst with concentrated sulphuric acid ngaiol is completely

resinified. With thionyl chloride and pyridine, ngaiol chloride gave an unstable chloride, $C_{11}H_{23}O_2Cl$, which easily lost a molecule of hydrochloric acid, when treated with alcoholic potash, to form dehydrongaiene dioxide. These experiments prove the presence of two oxide rings in the molecule of ngaione.

The presence of three double linkings in dehydrongaiene dioxide is proved by the molecular refraction, and by hydrogenation, when three molecules of hydrogen are absorbed with the formation of tetrahydrongaiene dioxide, $C_{15}H_{28}O_2$.

The Decomposition of Carbon Monoxide in the Corona due to Alternating Eletric Fields. Part II. By R. W. Lunt and R. Venkateswaran.

A preliminary quantitative investigation has been made of the properties of the substance which is formed when carbon monoxide, at pressures from 200 to 690 mm., is subjected to ionisation by collision produced by alternating electric fields of frequency two hundred and fifty cycles per second. It has been shown that this substance reacts with water forming carbon dioxide, a brown solution containing insoluble residue; and that, when removed from the vessel in which had been produced, it has the empirical composition represented by C_5O_3, x H_2O.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Stability of Large Power Systems. By F. H. Clough, C.B.E., Member.

Summary.

The paper deals with the stability, voltage control, and power limits of electric power systems and machines—more particularly, large alternating-current systems. The subject is dealt with in the following sequence :—

- Definition of stability.
- Stability and power limits of simple circuits.
- Larger power lines.
- Artificial stability of power lines.
- Natural stability and power limits of alternators and synchronous machines.
- Short-circuit and transient stability of alternators.
- Internal reserve of excitation of synchronous machines.
- Artificial stability of alternators.
- Stability of exciters.
- Types of electric power supply systems.
- Feeders and transmission lines and their voltage control.

The conclusions reached are that synchronous machines can be made sufficiently stable for all the usual purposes of power supply, and that the power limit and voltage regulation of transmission circuits depend principally on their series reactance.

The smaller power systems in this country are being grouped together to form larger systems, and the larger ones are growing and are being interlinked. In some cases this growth is the result of evolution and is following economic demands, and in others efforts are being made to coordinate the various parts of the system so that they conform with the general scheme contemplated. It would seem to be a fitting time to initiate a discussion on the fundamental principles underlying stability of power supply.

The stability of a system may be defined as its ability to respond to the power demands for which it was designed. The stability limit is usually reached when the power which can be transmitted over a line, or can be obtained from an alternator, is a maximum. As stability and voltage regulation are very closely associated, stability may also be expressed as ability to maintain voltage under the varying conditions of load for which a system, circuit or machine is designed.

Generally speaking, transmission and distribution systems in this country are comparatively short, and have been arranged to give reasonably good voltage regulation, so that lack of stability has not been troublesome; but in America and elsewhere, where power is being transmitted over long distances, it is being found that stability is becoming a subject for very careful investigation. Although transmission and distribution circuits in this country are usually stable, we are probably nearer to the instability point on large synchronous machines than is generally realised.

THE OPTICAL SOCIETY.

An Ordinary Meeting of the Optical Society was held at the Imperial College of Science and Technology on Thursday, 10 February, 1927.

Mr. T. Smith, M.A., F.Inst.P., delivered his Presidential Address on " Some Uncultivated Optical Fields," of which the following is a brief summary :—

" A Graphical Method.

The properties of an optical system over the whole image field may be explored

rapidly and with useful accuracy by geometrical drawing if the loci of secondary foci are substituted for the primary foci usually considered. The surfaces of constant magnification for light meeting the refracting surface in the neighbourhood of a given point are then strictly spherical, and ruler and compasses are adequate tools for the investigation of all the properties of the image. The same construction applies to thin lenses, and for lenses which cannot be classed as thin a slight modification of the method overcomes the difficulties of investigation by drawing.

Any single lens has many properties which may advantageously be related to a particular sphere which passes through the "centre" of the lens, the axial point through which rays suffering minimum deviation pass, and, with a positive lens, through the circle in which the two spherical surfaces of the lens meet one another.

This graphical method is recommended for the investigation of 'best form' spectacle lenses, and is likely to be of value in the preliminary exploration required in the evolution of new forms of photographic lenses.

THE CHARACTERISTIC FUNCTION.

A simple method of deriving the properties of one of Hamilton's characteristic functions is given. It is shown by its aid that even in the best corrected lenses the form of the constant fagnification surfaces is spherical instead of plane, though for a single magnification the curvature may be zero. The spherical field can therefore with advantage be taken as the normal form to which deviations should be referred. The practical utilisation of Hamilton's method depends on our ability to construct the function for optical systems having surfaces of any given shape. It is shown that this can always be done, and that the function satisfies an algebraic equation of finite order if the Cartesian equation to the surface is of finite order.

The characteristic function assumes different forms depending on the number of surfaces in the corresponding optical system. It should therefore be possible when a new lens is to be designed to determine from the conditions it is necessary to satisfy how many surfaces are needed and to determine the part to be played by each. It is then a simple proble mto determine the form to be given to each surface and the refractive index needed for each glass. The problem of finding the shape of the refracting surface from the characteristic function is essentially the same as that involved in finding the latter when the former is known. The optics of the future, it is held, is likely to depend essentially in the use of the characteristic function.

THE BALANCING ABERRATIONS.

The best balance between conflicting conditions may be secured over the whole field simultaneously by the use of the characteristic function and the theory of functions of minimum variation. When, as in the optical problem, several independent functions are involved, the basis on which the compensation is to be effected is described. The problem requires much fuller investigation than it has yet received when the limiting values assumed by the different variables are not independent.

As a special application of properties noted under the preceding heads it appears that it should be possible to design optical systems by calculations on equivalent lenses which are 'thin' in the usual sense. For the actual construction the equivalent 'narrow' or 'slim' lenses would be employed, a 'narrow' lens being a 'thick' lens which is no thicker than it need be in order to attain the required aperture and possess the strength to withstand the treatment to which it is subjected in manufacture. The correlation of the properties of 'thin' and 'narrow' lenses is likely to prove a fruitful field."

At the Annual General Meeting which followed, the accounts, balance sheet, and reports of the Council, Treasurer, and the Auditors for the Session 1926-27 were presented and approved. The Officers, Council, and Auditors were thanked for their services.

A vote of thanks to the Governors of the Imperial College and to Professor Callendar, for granting the use of rooms and other facilities for the meetings of the Society, was carried with acclamation.

The following gentlemen were elected as Officers and Ordinay Members of Council for the Session 1927-28 :—

President—R. S. Clay, B.A., D.Sc., Northern Polytechnic Institute, Holloway Road, N.7.

Vice-Presidents — F. F. S. Bryson, M.B.E., M.A., B.Sc., F.Inst.P., 102, Knollys Road, S.W.16; H. H. Emsley, B.Sc., Northampton Polytechnic Institute, Clerkenwell, E.C.1.; J. Guild, A.R.C.S., F.R.A.S., F.Inst.P., National Physical Laboratory, Teddington, Middlesex; F. C.

Watts, Shirley, Court Lane, Dulwich, S.E.
Hon. Treasurer—Major E. O. Henrici, R.E. (ret.), F.R.A.S., F.Inst.P., River House, The Terrace, Barnes, S.W.13.

Hon. Secretaries—(Business) Prof. A. F. C. Pollard, A.R.C.S., A.M.I.E.E., F.Inst.P., Imperial College of Science and Technology, South Kensington, S.W.7. (Papers) W. B. Coutts, M.A., B.Sc., F.R.S.E., F.R.A.S., Artillery College, Woolwich, S.E.18.
Hon. Librarian—J. H. Sutcliffe, O.B.E., F.Inst.P., 10, Clifford's Inn, Fleet Street, E.C.4.

Editor of Transactions—John S. Anderson, M.A., D.Sc., Ph.D., National Physical Laboratory, Teddington, Middlesex.

Council — D. Baxandall, F.R.A.S., A.R.C.S., 28, Dunmore Road, Wimbledon, S.W.; W. M. Brett, 50, Pollard Road, Whetstone, Middlesex; E. F. Fincham, Northampton Polytechnic Institute, Clerkenwell, E.C.1.; E. T. Hanson, B.A., Admiralty Research Laboratory, Teddington, Middlesex; Instr.-Comdr. N. M. S. Langlands, R.N., Royal Naval College, Greenwich, S.E.; Professor A. O. Rankine, O.B.T., D.Sc., Imperial College of Science and Technology, South Kensington, S.W.7; H. C. Raxworthy, 12-13, Eagle Street, Southampton Row, W.C.1.; J. Rheinberg, F.R.M.S., F.R.P.S., 12, Brondesbury Park, N.W.; G. F. C. Searle, Sc.D., F.R.S., Wyncote, Hills Road, Cambridge; W. Swaine, B.Sc., 89, Empress Avenue, Ilford; R. S. Whipple, M.I.E.E., 15, Creighton Avenue, Muswell Hill, N.10.; Col. H. S. L. Winterbotham, Geographical Section, General Staff, The War Office, Whitehall, S.W.1.

NOTICES OF BOOKS.

Les Sucres et leurs Dérivés, par Marc Cramer, Docteur ès-sciences de l'Université de Genève. Préface du Professeur Pictet. Pp. 260. Paris : Gaston Doin, 8 Place de l'Odéon. 1927. Price 28 francs.

Au cours de ces dernières années, la chimie des sucres s'est transformée et compliquée. Des faits que l'on croyait acquis, des formules que l'on croyait établies ont dû être révisés et soumis à une critique sévère. Ainsi en a-t-il été de la formule du glucose, le mieux connu cependant des sucres, et de la présence du glucose ordinaire dans l'organisme vivant. Il est donc très difficile de se reconnaître dans l'amas des données contradictoires qui ont été publiées sur la chimie des sucres.

Renonçant à entrer dans tous les détails de son sujet, l'auteur a voulu écrire un traité destiné à être *lu* plutôt qu'a être *consulté* et il a voulu indiques non seulement l'état actuel de nos connaissances, mais aussi l'importance des nombreux points obscurs qui subsistent et la direction dans laquelle il semble que les travaux futurs devront s'orienter.

Le volume se termine par un index bibliographique abondant poussé jusqu'au milieu de 1926 et que l'auteur s'est attaché à rendre aussi complet que possible surtout en ce qui concerne les publications récentes. Le lecteur aura donc toute facilité pour se reporter aux articles originaux.

The Secret Tradition in Alchemy. By A. E. Waite. Pp. XXII. + 415. London : Kegan Paul, Trench, Trubner & Co., Ltd. 1926. Price 15s.

In recent years Alchemy by itself has not attracted much attention. Nothing is now heard of the French Alchemical Society and ours in this country only had a few years' existence.

There are two classes of people interested in the subject—those attracted by Mysticism and Occult phenomena, and a few scientists concerned with the history of chemistry.

The scientists are interested in the experimental achievements of their early predecessors and also in the conclusions which were drawn from these practical researches. Those of the first group have restricted their attention to the Symbolism in alchemical writings. This has been especially noticeable in "A Suggestive Enquiry into the Hermetic Mystery," by Miss M. A. Smith (afterwards Mrs. Atwood), and in the writers who followed her lead in 1850. Mr. Waite, who is one of the greatest living authorities on Alchemy, has been to much trouble in examining this interpretation of alchemical literature. The contention of Mrs. Atwood is that, in their obscure language, the general purport of the alchemists was to emphasise the 'purification of the soul,' and expressed it in terms of a transmutation of base metal into gold.

In his review of the long succession of texts from Byzantium onwards, Mr. Waite demolishes this hypothesis in a forceful manner. The expositors of spiritual alchemy include, for instance, the 'Triumphal Chariot of Antimony' attributed to Basil Valentine (1604) in the category of spiritual revelations but, as the author points out, it is replete with remarkable chemical discoveries. Many of the methods described are followed exactly to-day, and such a practical treatise on the chemistry of anitmony and its compounds cannot possibly have been written as a work of spiritual symbolism. The same applies to many other alchemical tracts. The achievements of the Arabians equally afford evidence in favour of Mr. Waite's views.

Concerning the transmutation of lead or mercury into gold and silver, Mr. Waite points out that at the end of the sixteenth century claims were made everywhere, but the evidential fact was nowhere. This led, especially in Germany, to much antagonism and misunderstanding, as he has been at length to tell us here and in his "Brotherhood of the Rosy Cross" (see the *Chemical News*, 1924, cxxvii., 418.)

J. G. F. D.

FORTHCOMING EVENTS.

UNIVERSITY OF LONDON.

University College, Gower Street, W.C.1.)

Wednesday, March 2, at 5.30 p.m.—"Volta." A public lecture by Mr. W. H. Patterson, M.Sc., of East London College. Chairman : Professor A. W. Porter, F.R.S.

Friday, March 4, at 5.30 p.m.—Rhodes Lectures : "The Judicial Committee of the Privy Council." First of a course of three public Lectures by Professor J. H. Morgan, K.C. March 4, 11 and 18. Chairman, 1st lecture : The Lord Chancellor, the Rt. Hon. the Viscount Cave, G.C.M.G. Chairman, 2nd lecture (5 p.m.) : The Secretary of State for India, the Rt. Hon. the Earl of Birkenhead.

ROYAL SOCIETY OF ARTS.

Wednesday, March 2, at 8 p.m.—Ordinary Meeting). Ulick R. Evans, Member of the Corrosion of Research Committee of the Department of Scientific and Industrial Research, "The Corrosion of Metals at Joints and Crevices."

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Ordinary Meeting in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C.2., on Thursday, March 3, 1927, at 6 p.m. The following papers will be read : "Illuminating Engineering." By J. W .T. Malsh, M.A., M.Sc. "The Problems of Public Lighting by Electricity." By Lieut.-Commander H. T. Harrison, R.N.V.R.

Demonstration of Apparatus. — This meeting will be preceded, at 5.30 p.m., by a demonstration in the Common Room by Mr. Ll. B. Atkinson, of an Electro-Pneumatic Lamp. The lamp, in which hydrogen is generated, was patented in 1807, and the one to be demonstrated is believed to be the only example known. It is ignited by a spark from an electrophorus.

East Midland Centre, at University College, Nottingham, at 6.45 p.m.

Major Beard, M.Sc., and T. G. N. Hallane, B.A. : "The Design of City Distribution Systems, and the Problem of Standardisation."

SOCIETY OF PUBLIC ANALYSTS.

The Annual General Meeting of the Society will be held on Wednesday, March 2, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m.

The Accounts for the year will be presented, the President will deliver his Annual Address, and the Election of Officers and Council for the ensuing term will take place. The appointment of Auditors will be made.

The Ordinary Monthly Meeting of the Society will be held immediately following the Annual General Meeting, when the following Papers will be read :—

"Cacao Butter Substitutes and their Detection." By A. W. Knapp, B.Sc., F.I.C., J. E. Moss, M.Sc., A.I.C., and A. Melley.

"The Detection of Illipé Butter in Chocolate." By H. W. Bywaters, D.Sc., F.I.C., F. T. Maggs, M.Sc., A.I.C., and C. J. Pool.

"A Study of the Determination of Saccharin, Colorimetrically and by the Ammonia Process." (Work done under the Analytical Investigation Scheme.) By A. F. Lerrigo, B.Sc., F.I.C., and A. L. Williams, A.I.C.

GEOLOGICAL SOCIETY.

REPORT OF THE COUNCIL FOR E926.

During the past year 47 new Fellows were elected into the Society (5 less than in 1925), and 2 were reinstated. Of the Fellows elected in 1926, 29 paid their admission fees before the end of the year, and, of the Fellows who had been elected in the previous year, 17 paid their admission fees in 1926, making the total accession of new and reinstated Fellows during 1926 amount to 48 (2 more than in 1925).

The Society has lost during the year 51 Fellows (25 deceased, 8 resigned, and 18 removed). The total number of Fellows is as present 1,289, made up as follows: Compounders, 181; Contributing Fellows, 1,099; and Non-Contributing Fellows, 9.

The Receipts of the year, including the interest on the Sorby and Hudleston Bequests, and £145 transferred from the Voluntary Publication Fund, amounted to £4,367 14s. 7d. In addition, a grant of £400, made by the Royal Society in 1925, was in part expended on the Index to the List of Geographical Literature, 1920-25. The total expenditure of the Society amounted to £4,697 10s. 2d., but this sum includes £105 invested in 5 per cent. War Stock 1929-47 and £332 0s. 3d., part of the grant from the Royal Society, previously mentioned. The year opened with a balance in hand of £337 6s. 5d .,and closed with a balance in hand of £447 10s. 10d.

BRITISH SUBJECTS' PATENTS AND TRADE MARKS IN ESTONIA.

The Board of Trade are informed that on November 23, 1926, the Estonian Legislature passed a Law making special provision for the registration in Estonia of patents and trade marks belonging to British subjects which were registered in Russia before February 24, 1918.

Application for registration must be made within six months from the date on which the Law came into force.

A copy of an English translation of the law may be seen at the Public Library of the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C.2.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

3,050.—Anderson, I. B.—Production of benzanthrone derivatives. February 2nd.

3,159.—Bhisey, A. A.—Manufacture of eau-de-Cologne. February 1st.

3,24.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of anhydrides of acetic acid, etc. February 4th.

2,893.—Petroff, G.—Production of phenolic condensation products. February 1st.

3,022.—Soc. Anon. Produits Chimiques Coberlin.—Process of manufacturing vanillin. February 2nd.

Specifications Published.

264,558.—Dreyfus, H.—Manufacture of acetic acid.

242,306.—Zinke, Dr. A.—Process for manufacturing dyestuffs.

265,033.—Jarny, E. J. P. C. De.—Manufacture of condensation products from phenols and formaldehyde.

Abstract Published.

262,832.—Acetic acid.—Dreyfus, H., 8, Waterloo Place, London.

Acetic acid is prepared by passing carbon monoxide and hydrogen in equimolecular proportions at elevated temperature and pressure over substances which are, or are capable of forming, acetates which decompose with the formation of acetic acid at temperatures under 450° C., and if not themselves capable of combining the gases are associated with methanol-forming catalysts. Catalysts specified are copper oxide, tin oxide, lead oxide, copper acetate, aluminium methylate, tin methylate, or

mixtures thereof; alkali acetates or methylates may also be present. Zinc oxide and methane-forming catalysts are excluded. The pressures employed may rise to 200 atmospheres, but is preferably of the order of 50-150 atmospheres; the temperature does not exceed 450° C. and is preferably kept at 200-300° C. An example is given. Specifications 20488/13 and 262,494 are referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

GLYTHOID.

474,700.—A pharmaceutical preparation for human use.—Schieffelin & Company, 170, & 172, William Street, New York, United States of America. February 9th.

475,079.—Written signature of Dr. Madaus for all goods in Class 3, which includes chemical substances prepared for use in medicine and pharmacy.—Dr. Madaus & Co., Heinrichstrasse 175-175b, Radeburg, Dresden, Germany. February 9th.

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RADIATION AND THE PHOTO-ELECTRIC EFFECT.

By F. H. LORING.

Some fundamental ideas concerning radiation were introduced in a recent article by the writer (*Chemical News*, Feb. 18, 1927, p. 97). The photo-electric effect was briefly mentioned. The following may be read as an extension of the foot-notes.

So far as $h\nu_{sec}$ is concerned, the present-day opinion seems to favour the idea that this quantum of energy is only manifest as such in the exchanges of radiant energy; that is, just when such energy encounters or emerges from the atomic structure—specifically, when the atom absorbs or emits radiation.

In free space, or its equivalent, the wave-energy spreads and obeys the classical wave-theory without being done up in energy *bundles of $h\nu_{sec}$, there being then no discontinuity.*

Dr. Jeans suggested in his Rouse Ball lecture (see "Atomicity and Quanta," 1926, which is a reprint of this discourse) that the principle of reversibility or convergence might be introduced. This means that a highly diluted $h\nu_{sec}$, so to speak, as a spread-out wave, may in a reverse way converge on the atom and thereby satisfy the quantitative relation necessary to give the photo-electron the particular energy ($h\nu_{sec}$) to escape.

It is true that in electromagnetic phenomena of induced currents the energy of a large bundle of collapsing magnetic lines of force can be concentrated in a comparatively small single conductor, provided that the lines cut the conductor. In radiation proper there does not seem, however, a possibility of making use of this analogy for the photo-electric effect, yet it looks promising.

The photo-electric effect as a trigger action, pure and simple, has been proposed, but this idea presents several serious difficulties.

There is another process which, so far as the writer is aware, has not been considered. Since there are atomic electrons that lie intermediate in their position, that is, are rather near to the nucleus of the atom, might they not be responsive to a very weak radiation, provided that is has a sufficiently high frequency, whereby these electrons in responding to such radiation settle into still nearer positions round the nucleus? This would reduce the intensity of the binding field which is supposed to hold the outer electrons in their places or domains. As a result, at least *one* electron might then be liberated, and this electron, being no longer linked up with the atomic mechanism, joins issue on the similar $h\nu_{sec}$ terms*— which is the universally adaptable 'rate of exchange' —with radiation which propagates through

* Involving a sort of debit and credit balance : the amount of field neutralised by the closing in of the inner electrons balancing the energy the photo-electron acquires on taking its departure. Just here there would be a trigger effect, for the energy of the incoming radiation is not equal to the neutralisation energy, so to speak.

free space at a velocity of 2.9986×10^{10} cms. per second, thus tending to escape from the atom with an initial speed approaching this liming velocity†, this action taking place instead of an appreciable $h\nu_{sec}$ emission, when, as above, the inner electrons move nearer to the nucleus, and representing far more energy than that of the radiation absorbed.

This view in its crude form would be in conflict with some of the established facts known about the atom; but the interaction of feeble radiation of the proper frequency (above a limiting value according to the nature of the particular atom) with the atom might permit of a superposed condition of affairs not necessarily in conflict with the Bohr-Rutherford atom.

In conclusion, it must not be expected that the views here advanced are anything more than part theories devised to show possibilities in other directions than those generally considered. Such theories are, however, of particular interest at the present time when attempts are being made to build up elements by methods involving radiations, particularly radiations of high frequency. Jeans does not put forward the convergence idea as a solution of the problem, in fact his concluding words are : "not much meditation is needed to convince us that we are still very far from understanding the working of the atom or the true meaning of atomicity and quanta."

† In practice, falling short of this speed, of course.

A SELECTIVE DISPLACEMENT OF 0.0153A IN X-RAY SPECTRAL LINES. PART III.

By F. H. Loring.

On page 98 (*Chemical News*, Feb. 18, 1927), frequency per second, ν_{sec}, in a vacuum was given as $c\nu_{cm}$. The use of the word vacuum arose in this connection by definition, but it does not imply that the frequency would alter in the case of air being present, since light does not suffer a change in frequency in passing from a less dense into a more dense medium, or *vice versa*, as is well known. In such a case the wave-length is the variable as already shown. It must, however, be remembered that the above definition is such as to imply a very great distance. Whether conditions could exist whereby a very slight alteration in frequency can take place, as for example in the passage of light through luminous gas or vapour, is not within the writer's knowledge to answer.

It should be of interest to note that if the units are defined or correlated on a large-scale basis, comparable with the distance travelled by light in one second, say, as intimated above, 'cavity radiation' should perhaps then be re-considered with a cavity comparable in size with that of interstellar space. Then Newton's laws might apply, as they do generally for large-scale phenomena, radiation degrading into very short wave-lengths, which are possibly the observed cosmic rays, recently investigated by Millikan. The penetration of light through diffuse radiant matter has to be considered in this connection, since such material might be present in the hypothetical interstellar cavity. The Compton effect, as is well-known, is the reverse of the one here described; and, here, too, the definition of frequency should involve a vacuum standard as will be seen; for, without such a standard. conditions might arise whereby the frequency would be reduced. For the discussion of Newton's laws and the quantum theory, see Jean's "Report on Radiation and the Quantum Theory."

In astrophysics line displacements (– and +) are known, and enormous depths of luminous matter are often traversed. In some cases these shifts show fairly regular displacement differences, $\Delta\lambda$. This phenomenon in general has been attributed to the movement of the light source towards or away from the observer (Doppler effect), but the problem has not been completely cleared up. In addition to the Doppler effect, the theory of relativity predicts a shift of the spectral lines, for Einstein says : "An atom absorbs or emits light of a frequency which is dependent on the potential of the gravitational field in which it is situated." The frequency of an atom on a very massive star would be less according to Einstein and in such a case the spectral lines should show a displacement in the direction of longer wave-length. Such displacements have been observed which cannot be attributed to the Doppler effect.

It will be remembered that Eddington's prediction that stripped atoms (atoms without their normal quota of outer electrons) would come so close together as to produce stars of such enormous mass, and high density, that the Einstein shift might be expected. Furthermore that the small

companion star to *Sirius* might be such a star, as its motion was observed to be abnormal, or rather *Sirius* was apparently swung round as if its companion (*Procyon*) were a star of large mass, yet it was a comparatively small body. That such is the case was confirmed in a remarable way, for the line displacement was sufficiently in excess of that due to the Doppler effect to show that it was probably a small massive star made up as Eddington had conjectured. The great skill of W. S. Adams in effecting the measurement of displacement should be mentioned in this connection.

Referring to the previous part, it will be obvious to the reader that, on page 98, $\lambda \times 1.38887$ should read $\lambda = 1.38887$, and that on page 99, middle of first column, 10^{10} should read 10^{-10}.

On page 99, first column, electrostatic units are mentioned. It would have been a little clearer to have said *electrostatic* C.G.S. *units*, but this is optional.

On page 97, sixth line from top in right-hand column, " larger " should read " smaller." The *values* are larger but the *units* are smaller.

INDUSTRIAL CHEMISTRY IN JAPAN.

(*From the Journal of the Society of Chemical Industry, Japan.*)

Research Institutions and Scientific Societies.

From the early time of our history, there has been a few chemical industries such as textile industry, manufactures of pottery and urushiwares, or the saké-brewing, and it is nearly fifty-five years since the first lead chamber and the first cement kiln were built in the State-owned factories of the day, the two representing the earliest imported chemical industries. But it is only in recent years that progress in science and the industry has made big strides.

In the present system of the Imperial University here, the Department of Chemistry belongs to the Faculty of Science and the Department of the Applied Chemistry to the Faculty of Engineering. Of the latter we have four at present, namely in the Imperial Universities of Tokyo, Kyoto, Kyushu and Tohoku. The research work done by the staff is published very often in the Journals or Memoirs of the Faculty in one of the European languages, besides in some one of the periodicals of the scientific societies in Japanese.

The Research Institute for Iron, Steel, and other Metals of the Tohoku Imperial University and the Aeronautical Research Institute of the Tokyo Imperial University are specially for research work.

Of the universities supported by the public donations, only one, namely, the Waseda University, has a Department of Applied Chemistry.

The oldest research organisation relating to industrial chemistry besides the Universities, is the Tokyo Imperial Laboratory (Tokyo Kogyo Shikenjo) now in Yoyohata in the suburb of Tokyo. It is a Government institution founded in 1900 for the purpose of promotion of the chemical industry and comprises various branches such as fatty oils, paints, cellulose, coal tar products, ceramics, electrochemical products and so on. It publishes the work done there in its organ *in extenso* in Japanese and also usually in an abridged form, in the Journal of the Society of Chemical Industry, Japan. In 1918, the Osaka Imperial Industrial Laboratory (Osaka Kogyo Shikenjo) was inaugurated with a similar purpose in Osaka, the largest industrial centre of Japan. At the outbreak of the Great War, it was keenly hoped to synthesise ammonia, like the other belligerent Powers, although the fixation in the form of cyanamide had been for years a well-established industry here, and the outcome of the desire was the erection in 1918 of the Nitrogen Research Laboratory (Chisso Kenkyujo) at Meguro, Tokyo. In 1920, the Imperial Fuel Research Institute was founded and is now engaged in the investigations for the purpose of the best utilisations of coals of various grades. Besides those mentioned above, there are several laboratories belonging to various departments of the Imperial Government, in which investigations of more or less original character are carried on besides some routine work. As such are to be mentioned the Laboratory for Pottery (Tojiki Shikenjo) in Kyoto, one for silk industry (Kengo Shikenjo) in Yokohama, another for the brewing industry (Jyozo Shikenjo) in Takinogawa near Tokyo, and one of the Imperial Government Railways in Tokyo. Korean Government and the Government of Formosa have their own laboratories mainly for the chemical industries. These institutions have their organs of publication always in Japanese.

One of the most important of the research institutions is the Institute of Physical and Chemical Research (Rikwagagu Kenkyujo) at Hongo in Tokyo, which was

founded in 1917 by the public donations with a grant from the Government, for the purpose of accomplishing the original researches unrestricted in the subject, and we find that the industrial chemistry is well represented among the items of the investigations.

Turning to the scientific societies, the Chemical Society of Japan, in Tokyo, was founded in 1880 and comprises nearly the whole number of the scientific chemists of Japan. The Journal of the Society, in Japanese, had long been its sole periodical until last year, when another journal named "Bulletin of the Chemical Society of Japan" was initiated for the primary purpose of circulation abroad, and the articles therein are written in one of the European languages.

The Society of Chemical Industry (Kogyo Kwasgaku Kwai) was founded in 1898, in Tokyo and is now the greatest body of chemists with nearly 4,000 members either those engaged in research work or in factory. Its organ, the "Kogyo Kwagaku Zasshi" consists of two parts, one in Japanese and the other containing the abstracts in one of the European languages of the original communications in the Japanese text.

The Japanese Ceramic Association, founded in 1892, is one of the oldest scientific societies and has now about 1,500 members. The Fuel Society (Nenryo Kyokwai) was founded in 1922 for the purpose of promotion of the science and technology of fuels, either solid, liquid or gaseous. The youngest brothers are the Society of Agricultural Chemistry and "Cellulose Institute" both founded in 1925. All of these societies have their monthly journals, some of them having English abstracts of their Japanese original communications.

HOW BENDING OF LIGHT RAYS HINDER SURVEYOR.

HORIZONTAL REFRACTION MET WITH BY GEODETRIC ENGINEERS AT DIFFERENT POINTS IN CANADA.

When the blade of a straight oar is dipped into the water the submerged portion appears to take a direction different from that of the portion above the surface, giving the effect of an oar with a decided bend at the point of immersion. This bending is due to the fact that the ray of light, in other words the line of sight from the eye to the oar, is bent or refracted because the refractive power of water is greater than that of air.

This bending of lines which occurs whenever a ray of light passes through two or more mediums of different refractive power and which is to the layman only an interesting phenomenon, is the bugbear of the surveyor in his accurate measurements. The chief work of the Geodetic Survey of Canada is the determination of the exact positions of different points and their distances from and relations to one another. Geodetic surveys form the basis of all other surveys. The accuracy attained in these measurements is not commonly realised, it is such that should a 2-inch side of an erect scantling at a distance of 18 miles face the observer, the limit of error of angular measurement would be that caused by sighting on one edge of it, rather than on the other. To anyone standing on a hill at night and seeing a light across the valley it seems self-evident that he is looking straight at the light, whereas he may be, so to speak, looking at it along a curved line, so that the light does not appear in its true position.

Vertical refraction is always expected, and allowed for in observations of this kind. Horizontal refraction is not so common, but one of the outstanding instances of lateral bending of light, noticed by officers of the Geodetic Survey was met with when locating points along the lower St. Lawrence river. Here it was found that the lines across the river were apparently straight but that those along the shore were bowed toward the river. After many tests it was ascertained that this was caused by the fact that under certain conditions the air over the water was warmer, and therefore of a different density, at night when the observations were made, than that over the land, which fact caused the beam of light to be bowed toward the river and back to the instrument.

Last season in surveying lines along the Skeena river in British Columbia the phenomenon was noticed again but in this case a high cliff facing south and heated by the sun, raised the temperature of the air in its immediate vicinity and caused the rays to be bent toward itself, thus reversing the conditions found along the lower St. Lawrence river.

The deviation from the straight line in every case was very slight (in technical language from 3 to 20 seconds of arc) but still sufficient to render useless the calculations based upon the observation. In such cases surveyors overcome the difficulty by taking repeated observations on days, or at times of the day, when the layers of air over land and water are as near as possible of the same temperature and hence more nearly of the same density.

HOW FAR DOES SUPERPHOSPHATE PENETRATE THE SOIL?

By THOS. D. HALL, M.Sc. (Agric.), Chemist, School of Agriculture and Experiment Station, Potchefstroom; and
P. KAMERMAN, M.Sc., late Lectuler in Chemistry, Potchefstroom University College.

SUMMARY.

When a farmer has invested some of his hard-won gold in superphosphate he is very much interested in what happens to it after he has applied it to his lands. Especially is this the case when his crops have been a failure, due to drought, locusts ,or disease. The chemist has been able to comfort him by telling him that when once he has put down his superphosphate, the only way in which it will be removed from the soil is by crops. This view has been based largely on the "Phosphorus Balance-Sheet," which was drawn up by the Rothamsted Experiment Station some years ago. All the phosphates applied to the Broadbalk wheat plots in six decades could be accounted for, as all the crops taken off the land had been analysed and also the amount of phosphates escaping in the drainage water was known. The amounts of phosphate which it was calculated would be found in the soil, and the amounts actually found, agreed almost to a pound.

The drain guages at Rothamsted and the lysimeters at Cornell University show that only small quantities of phosphates escape from the soil in drainage water. It is a well-known fact that phosphates are fixed by the soil, but is it right to assume that they will be as well fixed on all types of soil as in the heavy clay loams of Rothamstead and Cornell? Will phosphates not penetrate a light ,sandy loam to a much greater depth? Will they not go far deeper into an irrigated land than a dry land? The senior writer has observed some wonderful results from top-dressing lucerne on a good loam with superphosphate. The roots of the lucerne were six to eight feet deep. On the other hand, he has observed no benefits to young barley with roots not six and seven inches long when top-dressed with superphosphate. The general experience is that it is better to apply the phosphates before planting annual crops.

The Texas Experiment Station (1) has satisfactorily answered some of these questions for the soils of the State. Representative soils were taken from all over the State to the number of 1,402 and superphosphate was applied to them at the rate of 2,300 lb. per acre ,about ten times as much as in actual practice. After standing twenty-four hours the soil in cylinders 14 inches deep was leached with water equivalent to 25 inches of rainfall. It was found that 10 per cent. of the surface soils and 28 per cent. of the sub-soils has a fixing power of over 80 per cent. The lighter sandy soils did not fix the phosphoric oxide as well as the heavier soils. In their conclusions it is stated that: "Heavy rains would be required to cause a loss of phosphoric acid, even from soils of low fixing power, under natural conditions. A rain of three or four inches within ten days might cause a loss of 3 or 4 per cent. of the water soluble phosphoric acid applied to light sandy soils with sandy sub-soils, having a fixing power of less than 50 per cent.'

It was also noticed that there was a definite ratio between the percentage of phosphoric acid fixed and the amount of iron oxides and alumina. These substances had a far greater effect on the amount of phosphoric acid fixed than had lime compounds. As the percentage of iron oxides and alumina increased, so did the percentage of phosphoric acid fixed increase. Hall and Vogel (2) in some preliminary work in this laboratory also ascertained that the soil with the most iron oxide alumina fixed the most phosphoric oxide.

The work of Wiley and Gordon (3) shows, however, that phosphoric acid absorbed by the colloids of alumina and ferric oxide, although it cannot be leached from the soil, is still available for plants. In the Texas work 2,300 lb. of superphosphate were applied per acre. This is about ten times as much as is applied in practice. If, according to their results then, the soil leached within twenty-four hours of stirring in the phosphate in the top 7 inches showed only a 10 per cent. fixation, it is likely that in practice and under a very much lighter leaching no phosphate would escape the second foot.

THE POTCHEFSTROOM EXPERIMENT.

No attempt has been made to investigate the many questions raised in this paper. During the season 1924-25, however, an endeavour was made by the writers to ascertain to what depth superphosphate was washed in the soil of the field husbandry experimental plots on a range a few yards north-east of the present greenhouse. A sample of this soil type, a brown loam, over-

lying andesite and shale, taken a few yards from the plots used, show an iron oxide alumina content of 18.68 per cent. in the first foot and 35.46 per cent. in the second foot. The second foot is very gravelly and consists largely of limonite concretions. In practice on this soil superphosphate has, however, given as good returns as bone-meal and more cheaply, in spite of the high fixation which would be expected. It is stated by some fertilizer companies that superphosphate has a tendency to become fixed in or near the surface of the soil, whereas bone phosphate tends to work downwards and so encourages the formation of deep roots, which give the plant a wider area from which to draw moisture during dry spells, and promote evenness of growth. Whether there are data to support this view, the writers cannot say, but the latter portion of the foregoing sentence has been found to be just as applicable to the plots receiving superphosphate on this soil type during the past eight seasons.

General Notes.

RIVER POLLUTION.

The pollution of English and Welsh rivers has reached such dimensions and raises such important issues that it must in the end demand Government action in some form or other. Questions of water supply, sewage disposal and fisheries have engaged the attention of Royal Commissions and Select Committees for over half a century which have all agreed that some central control is needed to hold the balance between the conflicting influences. The matter has again been raised by a deputation to the Prime Minister on February 15, from the British Waterworks Association and the Salmon and Trout Association, supported by other bodies.

It is urged that there is great need of scientific control to prevent harmful effluents, untreated sewage and industrial waste passing into streams which will sooner or later have to be tapped for water supplies. The consumption of drinking and domestic water is rapidly increasing and at the same time fishing is being restricted.

On its agricultural side the Ministry of Agriculture in encouraging the growth and manufacture of beet sugar, an industry consuming large quantities of water and giving an effluent harmful to river life which is said to be guarded by its other section.

SCHOLARSHIPS IN SCIENCE AND ENGINEERING.

The Board of Education have recently issued the syllabus for the examination to be held in April and May, 1928, for Royal scholarships and free studentships in science, tenable at the Imperial College of Science and Technology, London. There awards are open to British subjects of either sex, without age limit, and cover fees and, subject to evidence of financial need, such maintenance allowance, not exceeding £80 a year, as the Board think fit. The Board have also issued the regulations for the award of Whitworth scholarships for mechanical science in 1928 on the foundation of Sir Joseph Whitworth. These consist of two Whitworth senior scholarships of an annual value of £250, tenable for two years, and six Whitworth scholarships of an annual value of £125, which may be increased in special cases, tenable for three years. Candidates must be British subjects and have had handicraft experience in a mechanical engineering workship. The syllabuses and full details of the scholarships can be obtained from the Stationery Office or through any bookseller.

AGRICULTURAL ENGINEERING INTERESTS IN INDIA.

Agricultural and Engineers, Ltd., announce that Sir Charles E. Low, K.C.I.E., formerly secretary to the Commerce and Industry Department of the Government of India, and a member during the war of the Indian Munitions Board, has been appointed to take charge of the Indian interests of the fourteen engineering firms it controls.

PAGEANT OF CHEMISTRY.

Rainbow tints from black tar, sweet perfumes from evil-smelling pitch, fertilisers from the air, explosives, leather, enamel and lacquers from cotton waste, are but a few of the contributions of modern science to the welfare of mankind. All this modern magic was strikingly illustrated in the chemical section of the British Industries Fair at the White City, Shepherd's Bush.

The central and predominating stand of the section was that of Imperial Chemical Industries Ltd. This occasion was, as it were, the combine's first appearance in public, and its novel exhibit, bold and attractive in design, not only caught the eye but fittingly symbolised the world-wide scope and enormous interests of the new merger.

The products of each of the four companies in the merger, Brunner Mond, Nobel Industries, United Alkali, and British Dyestuffs Corporation, were allotted separate sections on the stand, while perhaps the most striking and informative of all was the section which demonstrated the co-relationship and inter-linking of the various products and processes of all four constituent firms. This was done by an ingenious arrangement of models and raw materials, with lines of coloured wire directing the eye through the range of processes and intermediate products down to the last and final product of all. By this clever device even the layman could glean an idea of how the various manufactures of the combine are linked up and of how the explosives and dyestuffs draw their materials from the heavy chemicals section, which in turn takes us back to the raw materials found in nature. On the top shelf of the stand were five raw materials, air, pyrites or sulphur, coal, brine and limestone. From these, the coloured wires ran down through different intermediate products to the manufactured explosive or the finished dyestuff on the bottom shelf. To even the casual observel this gave a simple picture of the highly complicated processes involved, and also a fairly adequate idea of how closely the work of the modern chemist enters into the daily needs and doings of each and every one of us.

From a chunk of coal to a gaily-coloured dress, or from a piece of pyrites to a stick of dynamite, may seem a long way to travel, but they did it in a twinkling of an eye at the British Industries Fair.

Messrs. Adam Hilger, Ltd., have just issued the December, 1926, number of their *Bulletin* of Development covering the last twelve months. It includes sections on their new instruments, the development of trade, recent references to Hilger Instruments, recent purchases of Hilger Instruments, and recent publications from their Research Department. The new instruments include a constant deviation wavelength spectrometer combination spectrographs and an ultra-violet spectroscope.

References have been made to their renowned instruments in many chemical and physical publications from all over the world.

It is interesting to note that more than half their sales is to foreign countries, Great Britain taking less than a third of their output. The *Bulletin* is apparently *gratis*.

THE HEATS OF FUSION OF CHLOROFORM, ACETONE, AND CARBON-BISULPHIDE.

By Shinroku Mitsukuri and Sennosuke Aoki.

(*Science Reports, Tôhoku Imperial University, Sendai.*)

The heats of fusion of organic solvents, whose melting points are relatively low, have scarcely been measured up to the present. O. Maass and L. J. Waldbauer measured the heat capacities of several organic solvents between various points at low temperatures and at room temperature with the adibatic calorimeter, and thence calculated their heats of fusion. Beckmann and his co-workers measured the lowerings of freezing points of solutions of organic solvents and calculated the heats of fusion of those solvents by the van't Hoff's formula.

The present authors also determined the lowerings of the freezing points of the solutions, and thence calculated the heats of fusion of several solvents by a thermodynamical formula. They, however, constructed an apparatus of new design, which was specially suitable for the determination of melting points with relatively small quantity of the samples.

The present experiments have not yet been finished, but it has become summer, and it does not now suit to continue the low temperature experiments. The authors, therefore publish this paper which describes the new apparatus and a part of the results of the experiments.

Summary.

1. The apparatus which is suited to determine the lowering of freezing point of organic solvent was described.
2. The lowerings of the freezing points of the solutions of chloroform acetone and carbon- bisulphide were determined, and their heats of fusion were calculated.
3. There were no indications of compound formation between acetone and chloroform.
4. The heats of fusion and the freezing points of m-xylene, chloroform, acetone, toluene and carbon-bisulphide are related linearly.

A part of the expenses of these experiments was paid from the research fund granted to one of the present authors (S.M.) from the Saito Gratitude Foundation.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on February 17, 1927 :—

The Mechanism of a Thunderstom. By G. C. SIMPSON, F.R.S.

A detailed description is given of the mechanism of a thunderstorm according to the theory in which the separation of electricity is brought about by the breaking of raindrops.

The orders of magniture of the meteorological and electrical quantities involved are investigated and shown to be in accordance with observations. The observations made by Schonland and Craib in South Africa of changes of electrical field strength produced by lightning discharges are examined in the light of the theory and found to be in complete accord.

Wolfer's Sunspot Numbers Considered as a Disturbed Periodic Series. By G. U. YULE, F.R.S.

When a series is subjected to periodogram analysis, there seems to be a tacit assumption that the series may be regarded as compounded of purely periodic functions and random (or largely random) superposed fluctuations. It is suggested that the series of sunspot numbers is analogous rather to the data that would be given by the observed departures of a simple pendulum subjected to random (or largely random) impulses. The graph of such a series is very smooth, but amplitude and phase are continually changing, just as with the sunspot graph.

The problem of determining period and "disturbances" for such a series is attacked by two methods :—

(1) By forming the least-square equation of the form appropriate to a simple harmonic function

$$u_x = ku_{x-1} - u_{x-2},$$

between three consecutive terms. Trial of the corresponding extended equation appropriate to two periods gave no evidence of the existence of any other than the fundamental.

(2) By forming the general least-square linear equation

$$u_x = b_1u_{x-1} - b_2u_{x-2},$$

and solving as a finite difference equation : the solution is a heavily damped harmonic function. Examination of the correlations between u_x and the preceding terms up to u_{x-5} again fails to give evidence of any period other than the fundamental.

The "disturbances" (divergences of u_x from the value estimated by the two preceding terms) show two conspicuous characteristics : (a) a tendency to be mainly positive and highly variable, mainly negative and much less variable, over alternate intervals of 40 to 42 years; (*b*) a tendency to be mainly positive during the rise of the graph, mainly negative during the fall.

The following papers were read in title :—

An Investigation of the Rate of Growth of Crystals in Different Directions. By M. BENTIVOGLIO. Communicated by Sir Henry Miers, F.R.S.

1. A method is developed by which relative rates of growth of crystal faces may be measured with accuracy, the crystal being grown in a rotating vessel.

2. Relative rates of face-growth are determined for crystals of isomorphous double sulphates of magnesium-ammonium, iron-ammonium and magnesium-potassium, and potassium and ammonium tartrates.

3. The measurements show that, under conditions of experiments, (i) similar faces of a simple form grow at same rate, even when of different sizes. Hence a misshapen crystal, if grown under uniform conditions, *tends* towards the ideal form. (ii) On a combination : unlike faces grow at different rates, like faces grow at same rate, except when adjacent to a large face of another fast-growing form. Except in this case there is a constant ratio between rates of growth of any two different forms. (iii) In crystals having no centre of symmetry rates of growth of parallel faces may be widely different. (iv) In isomorphous series the order of increasing rates of growth is not the same in different members.

4. For the sulphates mentioned "ideal forms" have been constructed, which a crystal would possess whose faces had grown at the observed rates.

The Quantum Theory of the Emission and Absorption of Radiation. By P. A. M. DIRAC. Communicated by N. Bohr, For. Mem.R.S.

The problem is treated of an assembly of similar systems satisfying the Einstein-Bose statistical mechanics, which interact with another different system, a Hamiltonian function being obtained to describe the motion. The theory is applied to the interaction of an assembly of light-quanta with an ordinary atom, and it is shown that it gives Einstein's laws for the emission and absorption of radiation.

The interaction of an atom with electromagnetic waves is then considered, and it is shown that if one takes the energies and phases of the waves to be q-numbers satisfying the proper quantum conditions instead of c-numbers, the Hamiltonian function takes the same form as in the light-quantum treatment. The theory leads to the correct expressions for Einstein's A's and B's.

At the meeting held on March 3, 1927, the following papers were read :—

The Structure of Certain Silicates. By W. L. Bragg, F.R.S.

An Investigation of the Rate of Growth of Crystals in Diverent Directions. By M. Bentivoglio.

Doppler Effects and Intensities of Lines in the Molecular Spectrum of Hydrogen Positive Rays. By M. C. Johnson.

The Transverse Magneto-Resistance Effect in Single Crystals of Iron. By W. L. Webster.

The following papers were read in title only :—

A Vector Loci Method of Treating Coupled Circuits. By E. Mallett.

The Thermal Conductiviay of Carbon Dioxide. By H. Gregory & H. Marshall.

Bands in the Secondary Spectrum of Hydrogen. By H. S. Allen and I. Sandeman.

The Constants of the Magnetic Dispersion of Light. By C. G. Darwin, F.R.S., and W. H. Watson.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Problems of Public Lighting by Electricity. By Lieut.-Commander Hadyn T. Harrison, R.N.V.R., Member.

Summary.

At the commencement of this paper the author points out that very little advance has been made in public lighting and that the conditions are very similar to those which existed in 1913. He contends that the demands of modern civilisation are such that the height, spacing and position of light sources should be re-arranged to avoid the use of very brilliant light sources and to reduce obstructions to vehicle and pedestrian which are liable to endanger the safety of the public.

For this purpose it is proposed that the light sources should be centrally suspended at frequent intervals by means of span wires, which, in order to reduce the cost and to simplify control and maintenance, should support the conductors.

Various examples of overhead suspension and of the usual method of supporting by means of columns are cited, with the object of comparing these with suggested solution of the problem.

It is pointed out that modern gas-filled electric lamps, due to their light weight and the little attention required, are specially suited to the suggested method of support, and that when combined with the necessary conductors the whole overhead equipment is inexpensive and not unsightly.

Figures relating to the initial cost and operating expenses of the construction proposed by the author are given and are compared with the existing examples previously referred to.

The second part of the paper deals with side streets, lanes ,alleys and slums, which the author contends deserve immediate attention in order that the poorer classes should live under brighter conditions. In such cases he advocates a similar overhead construction at a reduced cost, which would result in increasing approximately two hundredfold the illumination at the dark parts.

High roads and arterial roads passing through populated districts and used by motor traffic form the subject dealt with in the last part of the paper. The author proposes that this class be illuminated by means of highly concentrated light sources similar to motor-vehicle head-lights and fixed at a considerable height to give the required vertical illumination advocated by automobile authorities, but so arranged that no illumination is required from the adjacent source, thus reducing the glare.

SOCIETY OF GLASS TECHNOLOGY.

The meeting of the Society of Glass Technology held in Sheffield on Wednesday, February 16, 1927, was a joint one with the Yorkshire Section of the Society of Chemical Industry. The following bodies also took part : The Sheffield Metallurgical Association, The Sheffield Section of the Institute of Metals, and the Sheffield Society of Engineers and Metallurgists. The meeting was devoted to a general discussion on Silicate Analysis. The following papers formed the basis of the discussion :—

A Critical Survey of the Method in Use for the Analysis of the Simple Glasses. By W. H. WITHEY, B.A.

The glasses comprised in the scheme normally contained silica, iron oxide, alumina, manganese oxide, magnesia, soda and potash, with sulphate, chlorides and sometimes the oxides of arsenic and antimony in small proportions. The soda-lime series of glasses was included, and lead glasses differed only in that they contained lead. Borosilicate glasses containing zinc, and other glasses of more complex compositions were excluded Attention was directed only to criticisms of methods and recommendations as to the best procedure in order to ensure the most accurate results. Referring to the question of the limits of accuracy possible in glass analysis, the author pointed out that the adoption of any standard became naturally a matter for personal opinion and experience. It was not unreasonable to suppose, however, that the limits of accuracy for the major constituents were in the order of $0 \pm .08$, calculated on the weight of the original material, and that the total for the best analyses should fall within the limits 99.75 to 100.20. A comprehensive examination of various methods was made under the following main headings :—I. General Survey; II. The Precise Determination of the Constituent Oxides; III. Suggested Scheme of Analysis; IV. Modifications of Above Scheme for Approximate Results for Purposes of Works Control.

Notes on Methods Used in the Analysis of Glasses. By VIOLET DIMBLEBY, M.Sc.

Stress was laid upon the precautions to be observed in the determinations of silica and alumina, even in the case of the simple glasses. There was great need for careful washing and for control of the temperature of " baking " the silica; for the latter the use of high temperature was strongly condemned. Experiments made with pure rock crystal indicated that nothing was to be gained by this practice, and when other constituents were present with the silica, as in a glass, serious contamination of the silica would arise. Passing to the study of the more complex glasses, consideration was given to the determinations of ferric oxide, ferrous oxide, manganese oxide, arsenious and arsenic oxide, lead oxide, titania, zirconia, zinc oxide, cobalt oxide, baryta, boric oxide, sulphur trioxide, chloride and fluoride. Difficulties that were likely to arise, and the precautions or modifications that were necessary under certain conditions, were indicated. The choice of method for the determination of any one of the constituents of a complex glass was determined by the qualitative analysis of the glass; that is, by the nature of the other constituents present. Reference was also made to alternative methods which might be adopted in some cases, where speed was of more count than absolute accuracy.

The Analysis of Refractories. By W. J. REES, B.Sc.Tech., F.I.C.

In the case of most refractories the finest grinding of the sample before fusion was necessary, while for a glass an exceedingly fine division was not absolutely necessary. For Fireclays containing three per cent. or more of iron oxide and titania, it was undesirable to heat the evaporated fusion at a temperature higher than 105° C. He found that above 105° there was an increase in the contamination of the silica. He contented himself with evaporating on a water bath. He cordially seconded Mr. Withey's recommendation of the use of methyl red as an indicator; it was very useful in cases where the materials contained large proportions of lime and magnesia. Reference was then made to the analysis of magnesite bricks, basic dolomites, sillimanite, chrome refractories and silica bricks. Sillimanite gave trouble in analysis unless care was taken in the fusion. For the determination of alkalies in fireclays, the author relied on the Lawrence Smith method. He expressed his great interest in a suggestion made by Dr. W. Rosenhain in the course of the discussion of Miss Dimbleby's paper, namely, the use of superheated water for the first breakdown of the original material. He (Mr. Rees) had tried the method in a small way, without getting very good results. The method, however, was worthy of further investigation.

Notes on the Analysis of Silicate Slags. By T. P. COLCLOUGH, M.Sc., B.Met., A.I.C.

A close knowledge of the compositions of the slags formed in metallurgical processes was of fundamental importance, and methods for their rapid and reasonably accurate analysis were necessary. A table was given showing typical analyses of various kinds of slags, from which it was seen that the slags were generally much less siliceous than glasses. Methods were then indicated for the determinations of silica, iron oxide, alumina, phosphate, manganese oxide, lime, magnesia, sulphur and vanadic oxide. In addition to the more precise methods indicated, it was necessary for the control of commercial processes, to be able

to make analyses of slage for certain constituents, with sufficient rapidity and accuracy to be a guide to the person operating the plant. In each of the separate operations in iron and steel making at least one constituent of the slag was of vital importance in either the control of the operation or the manner of disposal of the material produced, and a method for the determination of that constituent must be available. A few examples were given to illustrate this point.

GEOLOGICAL SOCIETY.

February 2, 1926.

The Geology of the Naparima Region of Trinidad (British West Indies). By Prof. Vincent Charles Illing, M.A., F.G.S.

The area around San Fernando (Trinidad) has long been regarded as the key to the geological history of Trinidad in Tertiary times. It is covered almost entirely by a series of sands, clays, and marls of Lower and Middle Tertiary age, the marls being responsible for the black soils which have become the home of the sugar-cane industry.

The study of these Tertiary deposits has shown that they have been formed in two separate basine, separated by an important zone of uplift extending from San Fernando in an east-north-easterly direction. The deposits of the two basins had at some periods remarkably different facies, and it has been necessary to introduce two separate basin, separated by an important each basin, and particularly on the border-land, is interrupted by repeated unconformities showing overlap and overstep on to the old shore-line.

The Upper Argiline, generally considered to be Cretaceous, is placed in the Upper Eocene on the evidence of the foraminifera, and is followed unconformably by a series of sands and silts, also of Upper Eocene age. The Oligocene appears to be only in part represented, but the late Oligocene and early Miocene Periods show a thick series of clays, marls, and sands. The marl facies is almost completely restricted to the southern basin, and is considered to be merely a facies of the more widespread foraminiferal clays. It changes rapidly, both in thickness and in lithology, when traced northwards and southwards, but is more consistent along the strike.

The rocks of the area are moulded by a series of thrusting movements that come generally from the northward, the main trend of the folding being east-north-easterly. In Northern Naparima the soft Tertiary strata are crumpled, isoclinally folded, and over-thrust. In the middle of the area the folding is still complicated, but is less intense and more irregular; while in the south the folds are open and more symmetrical.

Associated with the movements which have recurred at distinct periods in Tertiary time, there has been emergence of the central land-ridge and the formation of shallow-water beach deposits at the maximum phases of uplift. These deposits follow the main line of thrusting, and are themselves involved in the later thrusting movements.

A NOTE ON THE CALCULATION OF RESISTANCE TO AIR CURRENTS UNDERGROUND.

By E. C. Polkinghorne.

(Abstracted from the "Journal of the Chemical, Metallurgical and Mining Society of South Africa.")

The following notes relating to some calculations, which were made to determine the water-gauge for the 30ft. Walker fan at the State Mines, were read at a meeting of Ventilation Officers of the Witwatersrand in September last.

In presenting them, in somewhat amplified form, for publication in the *Journal* of the Society, the writer wishes to make it clear that the calculations were made by him purely as a matter of personal interest, and have no connection with any official investigation.

Early in 1924 it was decided to erect, at the top of No. 5 Shaft, a fan with a capacity of 900,000 cubic feet of air per minute, and the question arose as to what the water-gauge would be.

At that time the mine—for ventilation purposes—was divided into two sections, north and south.

Before these data could be utilised it was necessary to discover what portion of the total water-gauges, 3.35″ and 3.25″, was

due to shaft friction, to that the balance, due to the resistance of the airways and workings, could be estimated.

In order to compute shaft resistance a suitable co-efficient of friction had to be decided upon, and here arose a difficulty, for, as is well known, authorities on ventilation differ materially as regards the co-efficients to be associated with various classes of rubbing surface.

Mr. T. W. Fitch, in a paper on "Mine Resistance," read before the West Virginia Coal Mining Institute, gives a list of co-efficients, among which are :—

0.0146 for air passages which are timbered but otherwise fairly smooth, straight, *unobstructed*, and regular in size,

and

0.0182 for air passages which are timbered and moderately crooked, irregular, *obstructed* and rough.

Dividers and the landing stages in pump and ladderway compartments must obstruct a ventilation current to a considerable extent, so it was decided to work out the resistance of the shaft with 0.0165 as the co-efficient of friction—this figure is almost the mean of the two co-efficients already mentioned.

The formula $W.G. = \frac{K.S.V.^{2*}}{A \times 5.2}$ with 0.0165 as K, gave the following results :—

No. 1 Shaft :—

$$W.G. = \frac{.0165 \times 240{,}000 \times .27}{345 \times 5.2} = 0.6''$$

No. 2 Shaft :—

$$W.G. = \frac{.0165 \times 230{,}000 \times .36}{345 \times 5.2} = 0.75''$$

Balance for airways and workings 2.0″

Total. W.G. = 3.35″
Read at Fan.

---

*K = Co-efficient of friction.

*S = Area of rubbing surface in sq. ft.

*V = Velocity in 1,000 ft. p.m.

*A = Cross section area in square feet.

No. 3 Shaft :—

$$W.G. = \frac{.0165 \times 360{,}000 \times .24}{345 \times 5.2} = 0.8''$$

No. 4 Shaft :—

$$W.G. = \frac{.0165 \times 375{,}000 \times .41}{345 \times 5.2} = 1.35''$$

Balance for airways and workings 1.1″

Total. W.G. = 3.25″

∴ Read at Fan.

The perimeter of these shafts is approximately 100 ft.

It will be noticed that the water-gauge for the airways and workings of the north section was much greater than that of the same portion of the south section. This was entirely due to the fact that the drive which then served as the main return airway for the north section was far too small—the velocity of the air current being between 1,300 and 1,500 ft. per minute over a considerable distance. All the main airways on the south section being of adequate size, only the water-gauge 1.1″ could be considered when estimating the resistance likely to be offered by the mine airways and workings to the quantity of air the new fan was to handle.

Two or three months after adopting 0.0165 as the co-efficient for shaft friction, it occurred to the writer that it would be a simple matter to measure the resistance of No. 1 Shaft to the air flowing down it. This was done on a Sunday morning. The compressed air receiver on surface was opened and a water-gauge attached to the main air column at the bottom of the vertical shaft. This constituted, in effect, a huge water-gauge with one leg open to surface and the other open to the vertical shaft station. Through the courtesy of the engineering department, the north section fan was run, and water-gauge readings were taken at the bottom of No. 1 Shaft over a period of an hour; these readings varied between 0.6″ and 0.65″ W.G., practically confirming the *calculated* resistance. In other words, the choice of 0.0165 as the co-efficient of shaft friction was extremely fortunate, and its

confirmation gave one confidence in Mr. Fitch's values for K.

This brings us to the calculations made to determine the water-gauge for the new fan.

Mine resistance, generally speaking, can be divided into four portions, namely :—

1. Pressure required to cause the air *to enter* the downcast shafts.
2. Pressure required to overcome the resistance of the " hardest " downcast shaft.
3. Pressure required to overcome the resistance of the airways and workings.

Taking these in order.

Item 1.—The downcast shafts are nearly 350 sq. ft. in area; consequently this item was almost negligible.

0.1″ W.G. will cover it.

Item 2.—No. 3 Shaft is the largest producer, and it was considered that 300,000 cu. ft. of air per minute would have to be sent down this shaft, which is one of the deepest; here then was the " hardest " downcast. 300,000 cu. ft. on the surface would become approximately 260,000 cu. ft. at the bottom of the vertical shaft (allowing for increased barometric pressure and decreased temperature), giving a mean volume of 280,000 cu. ft. per min.

$$W.G. = \frac{.0165 \times 360{,}000 \times 0.64}{345 \times 5.2} = 2.1''$$

Item 3.—Here one could only estimate. With the new fan in operation the quantity of air circulating underground would be doubled, and, if precisely the same airways were used, the velocity would perforce be doubled and, consequently, this portion of the resistance quadrupled. Obviously, however, with so much extra air at the disposal of the mine, additional splits would be established, and, moreover, ample provision was to be made in respect of main intake and main return airways. On going carefully into the matter it was thought doubtful whether the velocities of the currents in the airways and working places would be increased by even as much as 50 per cent. Also with a central upcast shaft the air would not have so far to travel. Therefore it was considered that by doubling the existing figure (1.1″) for the south section, generous allowance would be made for this portion of the mine resistance, say 2.25″.

NOTICES OF BOOKS.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. By J. W. MELLOR, M.Sc. Pp. X + 978. Price 63s. net. London : Longmans, Green and Co., Ltd., 39, Paternoster Row.

The present is Vol. VII. of the series and includes Tl. Zr, Hf, Ge, Sn, Ph, and the inert gases. The preceding volumes have been so well received by chemists and students generally that an equally favourable reception will be sure to be extended to the present volume. The author shews that titanium does not occur free in Nature, and he gives a succinct account of its discovery by M. H. Klaproth who, in 1794, analysed a specimen of mineral called Hungarian red Schörl. He inferred it to be the calx of a new metal to which he gave the name titanium, drawing upon his knowledge of mythology for the purpose. This observer seems to have explored the ground pretty fully and so did W. Gregar about the same time. The latter was obviously first in the field, but the other scientist was responsible for the name. The results were subsequently fully confirmed by several other investigators. The author deals carefully and fully with all the subjects referred to above and each chapter is followed by the various references, which renders consultation with them easy. Incidentally, we might say, the name of the *Chemical News* figures frequently in the reference tables. There are 225 diagrams, and there is given an exhaustive index. The volume is handsomely bound uniform with the previous volumes, and it will prove a valuable addition to any scientific library.

First Principles of Chemistry. By F. W. DAVISON, M.A., Sc.D., F.I.C., AND A. J. BERRY, M.A. London : Cambridge University Press, Fetter Lane, E.C.4. Urice 6s.

The authors state with justification that a book like the present will be found useful for students, not only because the information given falls in with and supplements that given in class-room or lecture-room, and also because those who possess a copy of it are relieved of the assiduous note-taking usually indulged in by students when attending lectures, and are thus the better able to concentrate their attention on the words of the professor. The work is arranged in chapters which gradually emerge from the purely elementary, leading

the student stage by stage to more advanced and, perchance, interesting problems in chemistry. The authors have had the friendly co-operation of several colleagues, and have produced a work which ought to have an extended circulation and especially as its price is so moderate as to place it within the reach of practically all students.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

Albemarle Street, London, W.1.

Monday March 7, at 5 p.m.—General Meeting.

Tuesday, March 8, at 5.15 p.m.—"Animal Growth and Development." By Professor Julian Huxley. (6).

Thursday, March 10, at 5.15 p.m.—"Progress of Hittite Studies." By Professor J. Garstang. (3)

Friday, March 11, at 9 p.m.—"The Wall of Hadrian." By Sir George Macdonald.

Saturday, March 12, at 3 p.m.—"Beethoven." By Dr. John B. McEwen. (With Musical Illustrations.) (3).

LONDON UNIVERSITY.

University College, Gower Street, W.C.1.

Monday, March 7, at 5.30 p.m.—"Fighting at Sea." A public Lecture by Capt. A. F. B. Carpenter, V.C., R.N. Chairman: Major-General Sir Frederick Maurice, K.C.M.G., C.B., Professor of Military Studies.

Wednesday, March 9, at 5.30 p.m.—"Photography of Documents: Object and Methods." A public Lecture by Sir William Schooling, K.B.E. (Apparatus will be exhibited.)

Thursday, March 10, at 5 p.m.—"History of Ancient Sculpture." A public Introductory Lecture by Professor E. A. Gardner. (Lantern Illustrations.)

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Hundredth General Meeting at the House of the Royal Society of Arts, John Street, Adelphi, W.C.2. Tuesday, March 8.—"Two Shallow Oilfields in Texas." By Arthur Wade, D.Sc., A.R.C.S., F.G.S., M.Inst.M.M., F.Am.G.S., M.Inst.P.T. The chair will be taken at 5.30 p.m.

THE INSTITUTION OF CHEMICAL ENGINEERS.

At the Chemical Society's Rooms, Burlington House.

Wednesday, March 9, at 5.30 p.m.—Papers by W. C. Freeman and S. J. Tungay. President, Sir Alexander Gibb, G.B.E., C.B.

Second Session, at 8 p.m. Papers by H. J. Bush, M.Sc.; A. Grounds, B.Sc.; and W. G. Mills. President, Sir Frederick L. Nathan, K.B.E.

Thursday, March 10, at 5 p.m.—Paper by B. D. Parritt, M.Sc.; at 8 p.m., Paper by F. C. Lea, D.Sc.

Friday, March 11.—Annual Meeting at 11.30; 8 p.m., Dinner at Hotel Victoria, Northumberland Avenue.

INSTITUTE OF METALS.

Wednesday, March 9, at 10 a.m.—

General Meeting in the Hall of the Institution of Mechanical Engineers. 2 p.m.—Paper on "Electric Furnaces in Non-Ferrous Metallurgy" will be presented. 7 p.m.—Annual Dinner and Dance at the Trocadero Restaurant.

Thursday, March 10, at 10 a.m. onwards.—Numerous papers by various authors.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Wednesday, March 9, at 8 p.m.—(Ordinary Meeting.) E. W. Smith, D.Sc., F.I.C., Technical Director, Woodhall-Duckham Companies: "The Utilisation of Gas Coke." Arthur Smithells, C.M.G., D.Sc., F.R.S., will preside.

Friday, March 11, at 4.30 p.m.—(Indian Meeting.) R. Mather: "The Iron and Steel Industry in India."

INSTITUTION OF ELECTRICAL ENGINEERS.

North-Western Centre. — Wednesday, March 8,—"Illuminating Engineers," by J. W. T. Walsh, M.Sc.; "The Problem of Public Lighting by Electricity," by H. T. Harrison.

Wireless Section.—Monday, March 7 at 7 p.m.—Discussion opened by Capt. P. P. Eckersley.

North Midland Centre. — Discussion opened by the President.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

3,609.—Baddiley, J. — Manufacture of dyestuffs. February 8th.

3,946.—Blythe & Son, Ltd.—Purification of sulphur. February 12th.

3,928.—Engelke, E. F.—Manufacture of vat dyestuffs. February 9th.

3,890.—Geigy Akt.-Ges., J. R.—Manufacture of acid dyestuffs. February 11th.

3,907, 3,908.—Leemans, J. P.—Manufacture of sulphuric acid. February 11th.

Specifications Published.

264,916.—Drescher, H. A. E., Smith, W., Thomas, J., and Scottish Dyes, Ltd.—Production of anthraquinone derivatives.

265,252.—Hammond, C. F., and Shackleton, W.—Method of and apparatus for the concentration or purification of caustic soda or other suitable material.

265,259.—Long, C. L., Willson, F. G., and Wheeler, T. S.—Manufacture of halogenhydrins.

265,267.—Levy, Dr. L. A., and Silberrad, Dr. O.—Process for the manufacture of cellulose acetate.

265,336.—Faithfull, S. E.—Process for making lactic acid and lactates.

Abstract Published.

263,340.—Tartrates; potassium bi-sulphite. —Klaverstelin, W. E., 1753, Patricias Mendocinas Street, Mendoza, Argentine.

In a process for extracting tartaric salts from wine lees and like materials in the cold with recovery of the solvent, the raw material is ground and 100 parts of water added for each 7 parts of potassium bitartrate in the material. The mixture is agitated and treated in a closed container with a current of sulphur dioxide until a pressure of 3 atmospheres is attained, stir- is dissolved forming potassium bisulphate and tartaric acid. The pressure is reduced without disturbing the chemical equilibrium reached, and after filtration the liquor is treated with vacuum in a closed container when the reverse reactions take place, the sulphur dioxide being drawn off and potassium bitartrate formed again and precipitating out of solution. This operation is stopper when a small amount, *e.g.*, 2 per cent., of the bitartrate remains in the solution so as not to precipitate the calcium tartrate present. The sulphur dioxide evolved may be used to treat a fresh batch. When, after repeated use, the mother liquor contains a relatively large amount of calcium tartrate, it is treated with a quantity of calcium bi-sulphite corresponding to the potassium salts still in the solution, and all the tartaric acid precipitated as calcium tartrate. The potassium bisulphite remaining in the solution is subsequently separated by concentration and cooling. Previous methods employed for the extraction of tartaric salts are referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ESTIVIN.

474,698.—A pharmaceutical preparation for human use for the relief of hay-fever.—Schieffelin & Ca., 170 & 172, William Street, New York, United States of America. February 16th.

BURGOYNE'S.

475,608.—Chemical substances prepared for use in medicine and pharmacy.—Burgoyne, Burbridges & Company, Ltd., High Street South, East Ham, London, E.6. February 16th.

ASFIN.

476,677.—Chemical substances prepared for use in medicine and pharmacy.—William George Twiddy, "Penryn," Gresham Road, Staines, Middlesex, February 16th.

476,617.—Circle bearing colours and the word KARLAC for chemical substances used in manufactures, photography or philosophical research, and anticorrosives.—P. M. Walker, Limited, 18, Cloth Hall Street, Huddersfield. February 16th.

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THE INTERACTION OF MANGANESE SALTS AND PERMANGANATES. PART I. THE ACTION OF POTASSIUM PERMANGANATE ON MANGANESE SULPHATE AND THE ESTIMATION OF MANGANESE.

By J. G. F. DRUCE.

The reaction which occurs when solutions of manganous salts are mixed with permanganates has been the subject of several researches since Gorgeu first examined it in 1862[1].

Soon after, Guyard[2] used this interaction for the direct volumetric estimation of manganese and expressed the reaction by the equation :—

$$3MnO, A + KO, Mn_2O_7 =$$
$$KO, A + 2A + 3MnO, Mn_2O_7$$

The ' manganous permanganate ' was then supposed to change to manganese dioxide,

$$3MnO, Mn_2O_7 = 5MnO_2$$

Guyard suggested that the following permanganates existed :—

$5\ MnO, Mn_2O_7$
$4\ MnO, Mn_2O_7$
$3\ MnO, Mn_2O_7$

and also the following manganites :—

$5\ MnO, MnO_3$
$4\ MnO, MnO_3$
$3\ MnO, MnO_3$

He stated that the reaction was rapid and exact although Gorgeu considered it unsuitable for volumetric work. Volhard[3], however, showed that the reaction could be made suitable for analytical work by the addition of a little nitric acid, the exact function of which was not understood. This volumetric method for the estimation of manganese has since been associated with Volhard's name, although it has undergone several modifications. He incidentally recommended this procedure for the preparation of pure manganese dioxide.

In 1909, Fischer[4] stated that it was not satisfactory to standardise the permanganate by means of ferrous salts or oxalates and then use it for manganese estimations. He recommended the use of a known manganous solution for the standardisation of the permanganate but the difference is not great. Deisz[5] explained the discrepancy that the oxide precipitate in this reaction was lower in oxygen than MnO_2 by assuming that (a) some of the manganous salt was adsorbed and (b) $Mn(OH)_3$ was co-precipitated. According to him the reaction is expressed :—

$$4\,Mn^{\cdot\cdot} + MnO'_4 + 8\,H^{\cdot} = 5\,Mn^{\cdot\cdot\cdot} + 4\,H_2O$$
and $$2\,Mn^{\cdot\cdot\cdot} = Mn^{\cdot\cdot} + Mn^{\cdot\cdot\cdot\cdot}$$

Some of the $Mn^{\cdot\cdot\cdot}$ escapes the latter decomposition and reacts :—

$$Mn^{\cdot\cdot\cdot} + 3\,OH' = Mn(OH)_3$$

His procedure in the estimation of man-

ganese was to dilute the solution to about 600 c.c. with boiling water in a litre erlenmeyer flask and add zinc oxide to neutralise any acid arising through hydrolysis. Excess of potassium permanganate was placed in a small beaker and added rapidly, the beaker being rinsed out with hot water which was added with the rest. After the precipitate settled the excess of the permanganate was titrated. Under these conditions it is claimed that no $Mn(OH)_3$ is precipitated, nor is there any manganous salt adsorbed in the hydrated manganese dioxide thrown down.

Cahen and Little[6], 1911, added zinc sulphate to the manganese solution as well as zinc oxide to neutralise any acid set free. The titration was carried out whilst the solution was hot and with shaking. When the colour of the permanganate persisted 1-2 c.c. of acetic acid were added and the titration was continued until the colour was really permanent. These authors recommend 0.2 normal permanganate and their method, on repeating, is found to be as convenient and accurate as any.

More recently Holluta and Obrist[7] have studied the reaction in the presence of excess of hydrofluoric acid, regarding the reaction as expressed by the equation :—

$$4\ Mn^{\cdot\cdot} + MnO'_4 + 8\ H^{\cdot} = 5\ MnO_2 + 4\ H_2O$$

They state that it proceeds smoothly and with the quantitative formation of the complex ion MnF''_5. Since the double salt K_2MnF_5 is deep red the presence of permanganate (end point of the titration) was detected by means of a pocket spectroscope. Their results were concordant, but it has been found difficult to repeat them successfully.

Sirkar and Dhar[8] have shown that whilst zinc is used in this titration to avoid the formation of 'manganese manganite,' almost any other cation is equally suitable. Those that they examined in this respect were $MgSO_4$, KNO_3, K_2SO_4, $CdSO_4$, $NaNO_3$, KF, LiCl, NaCl, $CaCl_2$, $SrCl_2$, $BaCl_2$ and sodium acetate.

It is usually supposed that zinc or calcium manganite is formed when zinc or calcium salts are present during the titration of manganous salts with permanganate, but these authors consider that it is more probable that the cation coagulates a colloid, whereby a part of the electrolyte is always adsorbed. They attempted to make manganites of metals in all the groups of the Periodic System by titration of their salt solutions with potassium permanganate and also by shaking freshly precipitated hydrated manganese dioxide with these electrolytes. In some cases it is obvious that only adsorption occurred. Thus the alkali metals do not form manganites under these conditions. The gold 'compound' contained less than 0.6 per cent. Au; the uranium 'compound' contained 0.95 per cent. U; and the platinum salt only 0.6 per cent. Pt. Most of the rest of the salts were of uncertain composition as the following list shows : —

$2\ CuO,\ 9\ MnO_2,\ 14\text{-}18\ H_2O$
$2\ MgO,\ 7\ MnO_2,\ 9\text{-}13\ H_2O$
$SrO,\ 7\ MnO_2,\ 11\ H_2O$
$CdO,\ 13\ MnO_2,\ 21\ H_2O$
$6\ Tl_2O_3,\ 5\ MnO_2,\ 7\ H_2O$
$Ag_2O,\ 7\ MnO_2,\ 9\ H_2O$
$CaO,\ 7\ MnO_2,\ 11\text{-}14\ H_2O$
$BaO,\ 7\ MnO_2,\ 7\ H_2O$
$Hg_2O,\ 11\ MnO_2,\ 6\ H_2O$
$PbO,\ 4\ MnO_2,\ 8\ H_2O$
$V_2O_5,\ 5\ MnO_2,\ 10\ H_2O$
$Bi_2O_3,\ 7\ MnO_2,\ 10\ H_2O$

Kolthoff[9] has also shown that a large number of salts could be used to cause the manganese dioxide to coagulate and thus facilitate the estimation. He expressed the reaction :—

$$3\ Mn'' + 2\ MnO''_4 + 2\ H_2O = 5\ MnO + 4H$$

More recently still Reinitzer and Conrath[10] have reviewed previous work and advocate the addition of sodium acetate and acetic acid as the best means to secure a sharp and accurate end point.

In their "Critical Studies on Methods of Analysis," it is noteworthy that Professor Congdon and his co-workers[11] make no reference to this method for the estimation of manganese and select three others as the most suitable for this purpose.

Thus the reaction which occurs between potassium permanganate and manganese sulphate may be represented by the equation :—

$$3\ MnSO_4 + 2\ KMnO_4 + 2\ H_2O = 5\ MnO_2 + 2\ H_2SO_4 + K_2SO_4.$$

when dilute solutions are used.

This representation of the reaction was given also by Sirkar and Dutta[12] for neutral or faintly acid solutions at 85° C.

Professor Partington, in his *Inorganic Chemistry*, page 969 (second edition, 1926) gives the equation

$$4\ KMnO_4 + 11\ MnSO_4 + 14\ H_2O = 4\ KHSO_4 + 7\ H_2SO_4 + 5\ Mn(HMnO_3)_2$$

but on what authority he does not state.

Gorgeu (*loc. cit.*) said that he had never observed the evolution of oxygen or chlorine (from manganese chloride) during these interactions, but oxygen is certainly evolved when concentrated manganese sulphate is added to a saturated potassium permanganate solution or to the finely powdered solid. With barium permanganate there is a very considerable evolution of oxygen. No manganous ions were detected in the filtrate which suggests that the reaction follows the course :—

$$Ba(MnO_4)_2 + MnSO_4 = BaSO_4 + 2\ MnO_2 + 2\ O_2$$

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RADIOMETRIC MEASUREMENTS ON THE CARBON ARC AND OTHER LIGHT SOURCES USED IN PHOTOTHERAPY.

By W. W. Coblentz, M. J. Dorcas, and C. W. Hughes.

(*Abstract of U.S. Bureau of Standards Scientific Paper* 539.)

Data are given on the distribution of energy in the spectrum of the carbon arc under various conditions of operation. The problem was attacked by two methods : (1) The energy distribution in the visible and in the ultra-violet spectrum of the radiation emitted from the central line through the arc and incandescent electrodes was obtained by means of a quartz spectroradiometer, and (2) by means of transmission screens the spectral radiation components of the whole arc, including the surrounding reflector, if present, were obtained in seven steps throughout the complete spectrum.

Data are presented on the variation in the radiation from the carbon arc, using different sizes and kinds of carbon electrodes, different kinds of cores, and the effect of a.c. and d.c.

Comparative data are given on the sun, the gas-filled tungsten lamp, the quartz mercury arc, and the arc between metal rods of tungsten and of nickel. The results obtained show that while the carbon arc approaches nearest the sun in spectral energy distribution it is important to use the proper size of electrode and current in order to obtain the most efficient operation of the lamp.

The high intensity arc was studied, and while it was found useful for large installations the same relative proportions of ultra-violet to the total emitted can be obtained from a small unit utilising 20 to 30 amperes as is obtained from the larger unit taking 90 to 125 amperes.

General Notes.

BRITISH COAL MINING.

Well over one million persons are now employed and the output of coal exceeds five million tons per week.

AUSTRALIA AND THE NEW ZEALAND APPLE TRADE.

The total production of apples in Australia and New Zealand during the year 1926 was estimated at 7,750,000 boxes and 1,940,00 boxes while exports totalled 3,175,000 and 715,000 boxes respectively, states the Empire Marketing Board, London. The chief individual producing centres were: Tasmania, 3,700,000 boxes; Victoria, 2,000,000 boxes; South Australia, 900,000 boxes; New South Wales, 650,000 boxes; and Western Australia, 500,000 boxes. Exports of apples from Tasmania amounted to 2,147,000 boxes ,other contributors being: Victoria, 400,000 boxes; South Australia, 315,000 boxes; Western Australia, 300,000 boxes; and New South Wales, 13,000 boxes.

SCIENTIFIC WORKERS' UNION.

This Union has not made very much noise in the scientific world—must have pursued a timid course. We are not acquainted with the nature of its constitution, and would be pleased to learn if there is looming in the offing the possibility of a militant policy, culminating in strikes, picketing, and intimidation, or if its programme is circumscribed by loftier ambitions. Even in the latter event there is a danger that the Union might be dragged into turmoil and conflicts by militant unions with which it might have a little more than nodding acquaintance.

SODA LAKES IN CANADA.

The crystal soda manufactured by chemical works, and commonly known as wash-soda, is a familiar product. Natron, which is the natural crystal soda of the same chemical composition and which is not commonly found native, occurs in considerable quantity in British Columbia, in small, undrained lakes which occupy shallow depressions over the southern portion of the Green Timber plateaux, just to the north of village of Clinton, one of the intergral plateaux forming the great interior plateaux of British Columbia, situated in the southern part of the province about midway between the Rocky Mountains and the Pacific.

According to present knowledge, practically all of the soda lakes of commercial importance, eleven in number, are situated within an area of about thirty square miles. This area is about ten miles north of Clinton and is traversed by the Pacific Great Eastern Railway.

The lakes are small, ranging from five to thirty-five acres in area. The depth of brine in the lakes containing the greater amounts of soda does not exceed three and a half feet. The available tonnage of natron in nine of the lakes examined is, on a preliminary estimate, about 200,000 tons. The largest single deposit contains about 70,000 tons.

In all except two of the lakes the soda is in solution during the greater part of the year, but when the concentrated brine is chilled by the cool autumn weather the soda crystallizes out in the form of natron. If the brine were not chilled and concentration by solar evaporation were to continue, the resulting deposit would be the mineral trena, a mixture of the carbonate and bicarbonate. This is the usual form in which soda occurs in natural deposits throughout the world.

The natron deposited each autumn forms in a bed from three to ten inches in thickness over practically the whole of the lake in most cases. It is very pure, containing as a rule less than one per cent. impurities. This material is suitable for marketing as sal soda or washing soda. It must be harvested during the autumn or winter, preferably the autumn, for then it is not contaminated with other salts that are later deposited from the brine. With the coming of spring this natron crystal redissolves.

In two of the lakes the soda is in crystalline form the year round. The crystals occur in large hemispherical masses in the muddy bottom of one of the lakes and as individual crystals disseminated through the mud in the other. This crystal is of the same composition as the surface crystal but of course is much contaminated with mud.

In addition to the lakes mentioned, there are numerous other alkaline lakes on the plateaux containing sodium carbonate in solution but not at present in such proportions than any is precipitated during the cold weather. These lakes are annually

lessening in volume and may yield soda in the future.

Analyses and further details regarding the material in these lakes are given, under the title "Sodium Carbonate in British Columbia," in Section V. of Mines Branch Report on Investigations of Mineral Resources, 1924 (No. 642), issued in 1926 by the Department of Mines, Ottawa, Canada.

Copies of a Special Report of the Department of Mines dealing with Sodium Sulphate in Western Canada can also be obtained on application to the Mines Branch at Ottawa, or to the Natural Resources and Industrial Information Branch, The Canadian Building, Trafalgar Square, London, S.W.1.

CHEMICAL INDUSTRIES EXPOSITION.

At the meeting of the Advisory Committee of the Chemical Industries Exposition, held at the Chemists' Club, New York City, Thursday evening, February 10, with Dr. Arthur D. Little of Boston presiding, numerous details of the coming Exposition to be held at the Grand Central Palace, September 26 to October 1, inclusive, were planned and discussed at length.

Mr. Charles F. Roth, co-manager of the Exposition reported very excellent progress with the Exposition to the Committee and that three floors of the Grand Palace had already been reserved.

The interest in the Chemical Industries Exposition shown by the leading educational institutions throughout the country is particularly gratifying. The Students' Course which will be conducted during the week of the exposition is divided into two groups, the first or elementary group and the second or advanced group. The results of such courses are very interesting and an extract from a letter from Professor W. T. Read, head of the Department of Chemistry at the Texas Technological College, Lubbock, Texas, reads :—

"In looking over the rolls for the two previous years brings out the varied types of students registered. Typical college undergraduates ,some graduate students, *some college instructors, and even profes*sors. Some men of wide and varied industrial experience, and several young men in the industrial field definately sent by their companies to attend the course. Naturally a considerable proportion of the group have no interest in academic credit of any sort, but are deeply interested in the subject matter of the course. I noticed during the last course that a number of exhibitors *dropped in to hear the lectures. It should* also be noted that a very considerable number of institutions are represented in our records. In gereral I think the course has shown a reasonable and satisfactory growth."

THE CONCENTRATION OF CANADIAN MOLYBDENITE ORES.

The mines branch of the Dominion Department of Mines has just issued a report (No. 670) by Mr. W. B. Timm and Mr. C. S. Parsons, dealing with the results of their investigations in connection with the convention of Canadian Molybdenite ores. The report sub-divides Canadian occurrences of molbdenite ores into their several types and gives concrete examples of the results obtained from the concentration of each type of ore, the procedure followed, the flow-sheet used, grinding, control of pulp densities, reagents, and manipulation of plant machinery to obtain the best results. In a number of cases the tests wer performed on carload lots of ore, under actual milling conditions, so that the results obtained are those that could be expected in practice.

Copies of the report may be obtained by parties interested on application either to the Department of Mines at Ottawa or to the Natural Resources and Industrial Information Branch, Canadian Building, Trafalger Square, London, S.W.1.

NOTE ON THE SILVER CONTENTS OF ROMAN LEAD FROM FOLKESTONE AND RICHBORO CASTLE.

By J. Newton Friend, D.Sc., Ph.D., F.I.C., Member, and W. E. Thorneycroft, B.Sc., Member.

(The Institute of Metals, March 9, 1927.)

Synopsis.

Specimens of Roman lead from Folkestone and Richboro Castle have been analysed. The former contained 0.0072, and the latter 0.0078 per cent. of silver.

Folkestone.—In August, 1923, East Cliff was definitely located as a Roman site, and in April, 1924, Mr. S. T. Winbolt directed the excavations undertaken by the Corporation. Foundations of two villas were found, and several objects of interest were unearthed, the best of which now repose in the local museum. The site was evidently occupied by the Romans before the end of

the first century, namely, A.D. 90, and appears to have been evacuated about the time of the Saxon raids, *circa* A.D. 388. Through the courtesy of Mr. Winbolt we have been able to examine several pieces of metal, including iron and lead. The iron specimens have been described elsewhere. The lead was a very soft, malleable mass. 25 grm. upon cupellation yielded 1.7 (9) mg. of silver, representing 0.0072 per cent., or 2 oz. 7dwt. 1 grain per ton. The cupel was very clean; a faint reddish-brown stain suggested a trace of bismuth, and a very slight dark stain round the bead might have been due to a trace of copper, and a small crack in the cupel possible indicates a trace of antimony. These impurities, however, could only have been present in the merest traces ;the silver bead was almost perfectly spherical.

Richboro Castle, the site of ancient Rutupiæ, is being excavated under the ægis of the Society of Antiquaries. The first Roman settlement probably dates from soon after the invasion of Claudius in A.D.43, and a more extensive occupation followed towards the close of that century. Through the kindness of Mr. Walter Klein we have been enabled to examine specimens of lead and iron. The latter have been described elsewhere (*loc. cit.*). The lead was appreciably harder than the Folkestone specimen : 25 grm. yielded upon cupellation 1.9 (4) mg. of silver—that is, 0.0078 per cent., or 2 oz. 10 dwt. 23 grains per ton. The cupel was not quite so clean as before; a reddish-brown stain indicated more bismuth ;a small light-coloured incrustation remained, suggestive of tin; and the presence of the merest traces of antimony and copper was indicated. The bead was again spherical.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

At the meeting on Thursday, March 3, the following papers were read :—

The Structure of Certain Silicates. By W. L. Bragg, F.R.S., and J. West.

The silicates present a highly interesting series of problems for X-ray analysis, because the number of crystalline forms is so large, and because they have been investigated very thoroughly as regards their crystallographical and optical properties, and the way in which isomorphous replacement of one constituent by another takes place. On account of their complexity and low symmetry a direct attack on their structure is difficult. Here an attempt is made to find the atomic arrangement by making use of certain characteristic features of oxygen compounds.

Wasastjerna suggested that the oxygen ion appears to occupy a much larger space in crystalline structures than most of the positive ions to which it is bound. One of the authors showed that in a number of oxygen compounds the form of the structure appeared to be governed almost entirely by a packing together of oxygen atoms, the other atoms being inserted into the interstices. The highly interesting form of silica investigated by W. H. Bragg, Gibbs, Wyckoff and others shows that this is true for silica as well as for the metallic atoms here studied.

We regard each series of silicates classified together as a mineral species, although with wide variation in chemical composition, as based on a characteristic type of oxygen assemblage. A number of structures are based on cubic or hexagonal arrangements of closest packing of oxygen atoms, the metal and silicon atoms being inserted into this framework. The dimensions of the unit cell are related to the fundamental spacings of this simple background of oxygen atoms, on which the complex pattern formed by the other atoms is embroidered. Closest-packing is found for an extended series of compounds, ranging from BeO, Al_2O_3, $BeAl_2O_4$, and $MgAl_2O_4$ to cyanite Al_4SiO_5, olivine $(Mg, Fe)_2SiO_4$, monticellite $MgCaSiO_4$, and the chondrodite $[(MgOH)_2Mg_3(SiO_4)_2]$ group.

The arrangement of oxygen atoms is in general more complex, closest-packing being an exceptionally simple case, but such compounds as have been analysed indicate that the packing of oxygen atoms remains the predominant feature of the structure.

An Investigation of the Rate of Growth of Crystals in Different Directions. By M. Bentivoglio. Communicated by Sir Henry Miers, F.R.S. (Revised and read by H. L. Bowman.)

1. A method is developed by which the relative rates of growth of crystal faces may be measured with accuracy, the crystal being grown in a rotating vessel.

2. Relative rates of face-growth are determined for crystals of isomorphous double sulphates of magnesium-ammonium, iron-ammonium and magnesium-potassium, and potassium and ammonium tartrates.

3. The measurements show that. under

conditions of experiments, (i) similar faces of a *simple* form grow at same rate, even when of different sizes. Hence a misshapen crystal, if grown under uniform conditions, *tends* towards the ideal form. (ii) On a combination : unlike faces grow at different rates, like faces grow at same rate, except when adjacent to a large face of another fast-growing form. Except in this case there is a constant ratio between rates of growth of any two different forms. (iii) In crystals having no centre of symmetry rates of growth of parallel faces may be widely different. (iv) In isomorphous series the order of increasing rates of growth is not the same in different members.

4. For the sulphates mentioned " ideal forms " have been constructed, which a crystal would possess whose faces had grown at the observed rates.

Doppler Effects and Intensities of Lines in the Molecular Spectrum of Hydrogen Positive Rays. By M. C. JOHNSON. Communicated by S. W. J. Smith, F.R.S.

The luminosity of hydrogen positive rays is examined with apparatus capable of maintaining constant electrical and gas conditions over very long exposures. About 150 lines present in the positive ray spectrum are listed, and also about 100 strong lines conspicuous by their absence. The grouping of intensities of the lines excited by high voltage positive rays is more akin to that found in the lowest voltage electron discharge than to that familiar in Geissler tubes. Five lines with Doppler components not before recorded are found, including one displacement to the red. The limiting intensities are measured, below which other Doppler components must lie.

From measurement of the Doppler components in both atomic and molecular spectra, evidence as to the carriers of both is found. Certain lines are carried by H_2, and only one is shown to be probably carried by H_3. The displaced Balmer lines are due to free atoms, not to those newly dissociated. The Fulcher characteristics of the secondary spectrum weaken towards the violet, as also does the ratio of displaced to undisplaced intensities in the Balmer lines.

The majority of the secondary lines are due either to radiation or to the impact of positive ions on stationary molecules which have not been recently ionised. The evidence of the Doppler effect as to the mechanism of the excitation of these groups in the secondary spectrum is contrasted with what is known of the low voltage electron excitation of a spectrum with similar intensity groups.

Bands in the Secondary Spectrum of Hydrogen. By H. S. ALLEN. Communicated by O. W. Richardson, F.R.S.

In a recent communication (Sandemann, Roy. Soc. Proc., A, Vol. 108, p. 607, 1925) on the secondary spectrum of hydrogen at higher pressures a band has been described, comprising a P, Q and R combination, and attributed to triatomic hydrogen. This has since been found to be one of a very considerable system of bands. These bands occur in groups, the bands of a group being spaced out at intervals of very nearly 92 wave- numbers, the spacing being in some cases approximately constant and in others conforming to a quadratic law. The bands are found both in the range of wave-lengths measured by Merton and Barratt and by Tanaka, and also in the infra-red region recently investigated by Allibone. Two groups occurring in the latter region have been considered in detail.

Experiment has shown that in some cases the lines of the groups are enhanced in the spectrum of the arc in hydrogen at higher pressures. The bands must originate in molecules with large moments of inertia, and other reasons are also advanced for believing that they are due to active or triatomic hydrogen. A complete analysis of their structure would prove an important step towards an understanding of triatomic spectra.

INSTITUTE OF CHEMISTRY.

At the forty-ninth Annual General Meeting of the Institute of Chemistry held at 30, Russell Square, Professor G. G. Henderson, President of the Institute, remarked that there appeared to be some abatement of the enthusiasm for chemistry as a career which was noted immediately after the war, although the roll of membership had increased by 242, during the year, to a total of over 5,200. It had not been the policy of the Institute to adjust the stringency of its regulations and examinations on any principle of supply and demand, but rather to indicate to those who believed that they had a bent for the science that it does not necessarily lead to fortune, that it calls for hard work and sacrifices, and, since the supply of chemists at present exceeds the demand, more than average ability is required for even moderate success. The industries of the country did not sufficiently

absorb the scientific talent supplied by the universities, and it was to be deplored that many graduates had to turn to callings which had no direct relation to their technical education.

The President then referred to the loss sustained by the death of Sir William Tilden, Past President, Sir John Burchmore Harrison, Prof. Edward H. Rennie, Dr. J. J. Acworth, Mr. John Webster, and others, and reviewed the work of the various Committees. He referred to the substantial legacy of about £5,000 bequeathed to the Institute by Sir Alexander Pedler, who would be gratefully remembered.

The Legal and Parliamentary Committee had made representations to the Departmental Committee on the Poisons and Pharmacy Acts regarding the use of the title, *Chemist*, which, in this country, as in no other, is confused with the profession and craft of pharmacy, and expressed the hope that the public would come to realise that it should be applied to those who seriously pursue the science and practice of chemistry in the investigation of the secrets of nature and in its application to the arts and manufactures. He knew that the difficulties were great, but hoped that the pharmacists, who were so fortunate in alternative designations, would realise how seriously the profession, to which they must acknowledge much indebtedness, was hampered by the existing confusion, and how far-reaching was the effect of this confusion in hindering the proper recognition by the community at large of the importance of the chemist and his science to the industries and trade of the country.

In October, the Institute will celebrate its Jubilee, and a medal and prize have been established in honour of the first President, Sir Edward Frankland, who held office from 1877 to 1880; the award will be made to a Registered Student for the best essay on a set subject of professional, as opposed to technical or purely chemical, importance. The subject for the first essay will be "The Importance of Chemistry to the Welfare of the People."

The Public Appointments Committee is reviewing the position of public analysts under the Sale of Food and Drug Acts, having particular regard to the increasing duties and responsibilities imposed upon these officers, in respect of which local authorities in general had allowed very little or no additional remuneration.

Discussions on the subject of registration were proceeding at meetings of the Local Sections of the Institute, which had been invited to submit concrete suggestions for the consideration of the Council. The Institute had been given authority in 1885, by Royal Charter, to examine, to grant certificates of competency, and to register persons qualified to practise chemistry, and the Council had done everything that reasonably could be done to provide for the admission to the ranks of the Institute of all who could claim to be trained and competent chemists. It was felt by many that the time had come to prepare some form of wider register of chemists of various grades, possibly with the ultimate object of securing powers for the restriction of practice to those who are duly qualified.

The position of the Institute was becoming steadily consolidated and its place in the affairs of the country more and more definitely acknowledged. Its sections in all parts of the country were united in striving to secure adequate recognition of the national importance of chemistry. He hoped that when industrial activity, which had been so much retarded in recent years, was more fully restored, chemists would have greater opportunities of showing what they could do to help in maintaining the economic position of the country, and would themselves participate in the results, on a scale more representative of their deserts than they had done in the past.

On the completion of his term of three years in the office of President, Professor Henderson acknowledged his appreciation of the support which he had received from the Council and Officers, and extended a welcome to Professor Arthur Smithells, C.M.G., F.R.S., who is to succeed him in the chair.

The Officers and Council for the ensuing year were duly elected as follow :—

President—Professor Arthur Smithells, C.M.G., F.R.S.

Vice-Presidents—Mr. E. R. Bolton; Dr. Harold G. Colman; Mr. E. M. Hawkins; Prof. G. G. Henderson, D.Sc., F.R.S.; Dr. R. H. Pickard, F.R.S.; Prof. J. F. Thorpe, C.B.E., F.R.S.

Hon. Treasurer — Mr. Patrick H. Kirkaldy.

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THE INSTITUTION OF ELECTRICAL ENGINEERS.

Short-Wave Wireless Telegraphy. By T. L. Eckersley.

Summary.

This paper deals with the state of the short-wave practice and theory, and describes experiments made by the author to elucidate short-wave transmission phenomena, and certain theoretical developments based on these experiments.

In the first section the aerial transmission characteristics are dealt with; in particular the vertical polar diagrams of transmission are computed taking account of the earth's resistivity, and it is shown that these are all characterised by the absence of horizontal radiation.

It is also shown that the intensity of the low-angle transmission is increased by raising the transmitting aerial.

In the second section the results of a series of experiments in which short-wave radio direction-finder is used, are described, and the conclusion is arrived at that in long-distance transmission the ray trajectory has a shallow angle of elevation 15°, and follows the great-circle path.

In the third section the results of a series of long-distance transmission tests is given. Waves between 25 and 10m were used, and experiments were made which indicated the superiority of a raised doublet over one at the ground level.

In the last section the general theory of ionic refraction is discussed in the light of these and other experimental results. The effect of attenuation due to the collision of electrons with molecules is especially stressed and a novel theory of the skip distance is put forward which has the merit of aggreeing closely with the observed results of Heising, Shelleng and Southworth.

THE INSTITUTE OF METALS.

The following papers were read before the meetings held on March 9 and 10 :—

An Etching Reagent for Copper. By Professor Bernard W. Holman, O.B.E., A.R.S.M., Member.

The note describes the use of silver nitrate as an etching agent for copper, and suggests its utility in research work. The intricate etching figures sometimes produced by this methor are commented on.

A small fragment of a dry crystal of silver nitrate is placed on the polished surface to be etched and a single drop of water allowed to fall on it. A light, loose deposit of metallic silver forms immediately, and in about three seconds turns grey. Both the crystal and the loose deposit of silver should then be washed off the copper surface by a small jet of water.

For ease of manipulation the specimen to be etched may be held by the left finger and thumb over a small porcelain evaporating dish. The right hand is then free for directing a jet of water from a wash-bottle when and as required.

If these operations are performed correctly, a beautifully etched, even clean surface will be obtained. On examining this

surface under the microscope very fine structures may be seen, but no silver is noticeable, as may be the case when using nitrate solution.

Unevenness or channelling of the surface may result if the wetted fragment of crystal is allowed to rest too long on the surface of the specimen. Such channelling, although sometimes causing intricate patterns, does not appear to be due to the structure of the specimens.

With a little practice this method of etching can be carried out quite quickly, and has the advantage that on a polished specimen 0.5 × 0.25 in. as many as five separate spots may be independently etched in rapid succession without any intermediate repolishing, the same crystal being used each time. This is useful in tests where the effect of different degrees or methods of etching may be of interest.

Magnetic Analysis as a Means of Studying the Structure of Non-Magnetic Alloys. By Prof. Kōtarō Honda, Sc.D., and Prof. Hikozō Endo, Sc.D.

The present investigation shows that magnetic analysis applied to the case of non-magnetic elements, which are paramagnetic or diamagnetic, affords a very convenient method of studying the equilibrium diagram for the alloys consisting of these elements. Not only is the melting point or the transformation point of an element given by a sharp discontinuity of the susceptible-temperature curve, but the liquidus and the solidus of an alloy are also marked by a sharp break or bend in the same curve. In some cases, small solubility is marked by a very large abrupt diminution of the diamagnetic susceptibility of one component on adding a small quantity of the other. The magnetic analysis is also a very convenient method for the study of the actual state of an alloy when above its melting point, that is, in detecting the existence of an intermetallic compound in the liquid phase, the degree of dissociation of the compound with the rise of temperature, etc.

Brittleness in Arsenical Copper. By Clement Blazey, M.Sc.

A description is given of a type of brittleness in arsenical copper tubing developed by annealing in the temperature range 450° to about 650° C. The susceptibility to brittleness was inherent in the "as-cast" billets from which the tubes were made, and no alteration in hot and cold working methods could eliminate it. The degree of susceptibility varied from billet to billet, but the variation could not be connected with chemical composition. After remelting, no trace of brittleness could be developed. Over a period of several years the brittleness was encountered in a certain mill on three occasions, and appeared to be connected with the composition of the refinery charges and with melting operations.

The Influence of Calcium on Aluminium Containing Silicon. By J. D. Grogan, B.A. With an Appendix on "The Estimation of Calcium in Aluminium Alloys." By P. G. Ward, B.Sc., A.R.C.S.

On addition of calcium to aluminium the compound $CaAl_3$ appears completely soluble in molten aluminium within the range examined, but very slightly soluble in solid aluminium.

On addition of silicon to this alloy the compound $CaSi_2$ is formed, completely soluble in molten aluminium within the range examined. In solid aluminium the solubility is extremely small at all temperatures. Neither $CaAl_3$ nor $CaSi_2$ appreciably improves the mechanical properties of aluminium, nor imparts any age-hardening properties to it.

The addition of suitable quantities of calcium to aluminium containing silicon improves the electrical conductivity of the aluminium by removing silicon from solid solution. As the influence of $CaAl_3$ on the conductivity of aluminium is relatively small, the effect of a slight excess of calcium is not harmful.

Investigation of the Effects of Impurities on Copper. Part V. The Effect of Bismuth on Copper. By Prof. D. Hanson, D.Sc., and Grace W. Ford, B.Sc.

This paper describes experiments made on copper containing up to 0.1 per cent. of bismuth, and the effects of small quantities of bismuth on the casting, hot- and cold-rolling, mechanical properties, electrical conductivity, and microstructure of copper.

The experiments confirm the great embrittling effect of bismuth, and indicate that when more than a trace of bismuth alone is present in copper, the working properties, particularly the cold-working properties, are seriously affected. The solid solubility of bismuth in copper has also been investigated.

The Penetration of Brass by Tin and Solder. With a few Notes on the Copper-Tin Equilibrium Diagram. By H. J. Miller, M.Sc., Student Member.

The cracking of stressed brass articles by a process of intercrystalline penetration

when in contact with molten solder of the tin-lead variety is associated with the phenomenon of "season cracking" and the penetration of mercury into brass. Tensile tests upon brass test-pieces which are surrounded by various molten metals and solders indicate that the stress required for penetration to take place is much higher than that required for the penetration of mercury ;experiments with stressed brass tubes also indicate that high stresses are required for penetration to take place.

Some subsidiary experiments with copper-tin alloys indicate that the eutectic composition of the series occurs with about 0.7 per cent. of copper as against 1 per cent. by Heycock and Neville, 2 per cent. by Guertler, Shepherd and Blough, and 5 per cent. by Giolitti and Tavanti.

Note on the Magnesium-Rich Magnesium Copper Alloys. By M. HANSEN, Dr.Ph.

The paper contains the results of investigation of the solubility of copper in solid magnesium and the mechanical properties of some magnesium-rich magnesium-copper alloys. Some indication of the phase boundary of the solid solution of magnesium with copper has been obtained. The microstructure of quenched and slowly cooled alloys is illustrated by means of photographs. The quenched alloys show no perceptible hardening by ageing. Some mechanical properties of extruded material both with and without heat-treatment are given.

The Penetration of Mild Steel by Brazing Solder and other Metals. By R. GENDERS, M.Met., F.I.C. (Communication from the Research Department, Woolwich.)

The cracking of mild steel under slight stress when heated and wetted with brazing solder is due to rapid intercrystalline penetration of the steel by the brass. Copper behaves similarly to brass, but zinc, tin, and lead-tin solder have no perceptible action. The behaviour of mild steel in comparison with that of other metals when stressed and exposed to corrosive media is considered. It is suggested that the phenomenon of intercrystalline penetration is in many cases of a complex character, involving a third factor.

The Attack of Molten Metals on Certain Non-Ferrous Metals and Alloys. By HAROLD J. HARTLEY, M.Sc.

The attack of molten tin and tin containing solders upon brass and copper have been studied, taking the time factor into consideration. Penetration of the molten into the solid material occurs when the latter is stressed in tension. Fully annealed materials are attacked at very low stresses with ultimate breakdown.

Investigation of the Effects of Impurities on Copper. Part III. The Effect of Arsenic on Copper. Part IV. The Effect of Arsenic Plus Oxygen on Copper. By PROF. D. HANSON, D.Sc., AND C. B. MARRYAT, B.Sc.

These sections describe investigations into the effects of arsenic alone, and of arsenic plus oxygen on copper. The tests described in Part III. have been made on a series of alloys containing up to 1 per cent. of arsenic, and the paper describes the effects of arsenic on the casting and working properties of these materials. Tests have also been made on the mechanical properties—tensile tests at ordinary temperatures and at 250° C., hardness tests, fatigue range, and notched-bar impact test; while the effects of arsenic on the electric conductivity, both at 20° C., and 65° C., have also been examined. The effects of arsenic on the macrostructure and microstructure of copper have also been determined, and the solubility of arsenic in solid copper has been investigated.

In Part IV. a similar series of tests has been carried out on copper containing up to 2 per cent. of arsenic and 0.1 per cent. of oxygen, with a view to ascertaining the influence of each of these elements on the presence of the other. In particular, the influence of arsenic in modifying the cold-shortness of copper containing oxygen has been investigated.

Experiments on the gassing of copper by hydrogen have also been undertaken with a view to ascertaining the influence ,if any, of arsenic on the gassing of oxygen-bearing copper.

The Application of Strain Methods to the Investigation of the Structure of Eutectic Alloys. By F. HARGREAVES, A.R.S.M., D.I.C., F.I.C.

The structural unit of the tin-lead eutectic may be a distinct eutectic "colony," or may be a unit in which only general lamination is present.

Deformation occurs in a manner similar to that of pure tin, and this suggests that the tin determines the orientation. This is supported by the manner in which an alloy with excess of tin deforms. An allow with excess of lead deforms in a manner similar to that of an isotropic solid. The orientation of the tin-zinc eutectic is apparently determined by that of the tin.

One of the structural units of the copper-silver eutectic is the eutectic "colony." Strain methods would appear to be widely applicable in the study of eutectics.

Examination of a Fifteenth-Century "Brass." By J. NEWTON FRIEND, D.Sc., Ph.D., F.I.C., AND W. E. THORNEYCROFT, B.Sc.

A brief account of the tomb of Richard Beauchamp at Warwick, and an analysis and micrographs of portions of the bronze stature were given.

The Mechanism of Inverse Segregation in Alloys. By R. GENDERS, M.Met., F.I.C. With an Appendix on "The Accurate Determination of Copper in Bronze by Electrolysis. By R. A. F. Hammond, B.Sc., A.R.C.S., A.I.C.

The hypotheses put forward to account for the occurrence of inverse segregation in alloys are critically discussed. None is fully in accordance with experimental fact, and it is evident that some factor is involved in the phenomenon, the influence of which has not yet been taken into consideration. Preliminary experiments are described showing that, in extreme cases of inverse segregation, exudation at the surface of the casting occurs simultaneously with the escape of evolved gases. The variation of composition in chill-cast slabs of bronze containing 5 per cent. tin made by various methods of casting were determined. The previous work of the author on the flow taking place in the mould during the formation of the ingot is considered in relation to these results. A general theory of inverse segregation is advanced, in which the gas constituent in alloys is considered as part of the system. The evolution of gas from solution in the metal is regarded as of primary importance in determining variations in composition in the solid casting. Representative experimental data are explained by means of the theory, and methods of avoiding inverse segregation are discussed.

FARADAY SOCIETY.

At the meeting held on October 1, 1926, the following paper was read.

Molecular Orientation in Solids. By DR. G. SHEARER.

In recent work it has been shown that, under suitable conditions, certain types of molecules have a strong tendency to form layers which, although not solid, possess a very high degree of orientation. This is perhaps best shown by the work of Langmuir, Adam and others, on the behaviour of thin films. When we consider the question of why and when such oriented films are possible, we arrive naturally at the conclusion that there must be a very close relation between these orientated collections of molecules and the crystalline state. In the crystal we have, so to speak, perfect and complete orientation of molecules. A small number of molecules, perhaps four, form themselves into a definitely orientated group and the repetition of this group in all directions results in the crystal.

We know very little as to the nature of the forces which cause the molecules to come together in this way, but it appears to be a safe assumption that, whatever their nature, the molecule even in the gaseous or liquid state possesses a tendency to link up in a very definite way with its companions; if the motions of the colecules due to thermal agitation and the like are sufficiently small, these forces succeed in binding the molecules together into the solid or crystalline state.

This assumes that the molecule in the solid is of very similar nature to the molecule in the liquid or gaseous state; there is, however, an ever-increasing volume of evidence in favour of this hypothesis. If this be granted, it would appear probable that, in those cases where a certain degree of orientation is found, this orientation should be that arising from the partial success of an attempt to form a true crystal. The arrangement of molecules in an oriented film, for example, should be a replica, more or less perfect of some aspect of the orientation found in the crystal.

It is fortunate that we have now a considerable collection of X-ray measurements of those substances, a study of which has proved so illuminating in thin film work—substances whose molecules are based on a long open chain of carbon atoms. This X-ray work, although still far from complete, appears to have established certain facts. A few of these which seem to have some bearing on the subject under discussion may be briefly summarised.

In the first place, a study of the structure of these long chain compounds shows that there is one set of planes in the crystal whose distance apart, or spacing, is very much greater than that of any of the other planes. Further, the value of this spacing increases uniformly as the carbon content of the molecule increased. This at once suggests that this spacing is closely con-

nected with the length of the molecule and confirms the chemical deduction that the carbon atoms are arranged in chain fashion. A study of a number of series shows that, for a given carbon content, the actual value of the spacing approximates to one or other of two values, one of which is just about double the other; or ,expressed otherwise, the rate of increase per CH_2 group is twice as great as in the others. This immediately suggests that in one case we have to deal with an arrangement in which successive identical planes are separated by a single layer of molecules, while in the other there is a double layer. A study of different series brings out the following empirical rule. If the molecule has at one end a group which is active chemically, *e.g.*, COOH, then the double layer will be found; if both ends are inactive, as in the hydrocarbons, only a single layer will occur. As it appears to be the active groups which result in the formation of the double layer, the natural conclusion is that the two layers are oppositely oriented, the active groups of the bottom layer being directed towards the active layer of the upper layer. This conclusion receives strong independent confirmation from a study of the intensities of the successive orders of reflection of X-rays from the long spacing plane. These intensities show that the arrangement of the molecules in successive layers must be head to head and tail to tail and not head to tail.

The importance of this active group is emphasised by an investigation of such series as the ketones, $C_mH_{2m+1}.CO.C_nH_{2n+1}$, and the esters $C_mH_{2m+1}.COO.C_nH_{2n+1}$. In general, these have inactive end groups . . . $CH_2.CH_2.CH_3$ and we find only a single layer. In the methyl ketones (whose end group is $CO.CH_3$) we find a double layer, showing that the carbonyl group is now sufficiently near to the end of make its effect felt. If the end group is $CO.CH_2.CH_3$ as in the ethyl ketones only a single layer is found, showing that the carbonyl group is now too far from the end to show itself in this way. Similar results are found in the ester series.

There is still some doubt as to the precise rrangement of the molecules lengthwise. t seems to be established that they set hemselves with the directions of their ength closely parallel to one another, but he angle which this direction makes with he normal to the basal plane is more diffiult to determine. There is considerable vidence to suggest that this angle varies rom one series to another, but has a distinct tendency approximately to adopt one or other of two values 0° or 30°, so that, while in some series molecules are standing vertically, in othere there is a distinct tilt amounting to about 30° from this vertical position. It is this variation in tilt which is probably the explanation of the change in the increment in spacing per CH_2 group from one series to another rather than any intrinsic change in the nature of the chain itself. Even the same substance has sometimes more than one stable arrangement, a transition taking place at a certain temperature. This change is reversible and is probably caused by a change in the tilt of the molecules from one stable position to another.

A study of the habit of the crystals of these substances enables us to form an estimate of the relative strengths of some of the bonds which join molecule to molecule. The forces which tie up the molecules side to side are much stronger than those which bind the layers together. This is shown by the extreme readiness with which the crystals cleave across a plane which passes through the ends of the molecules and is also reflected in the extreme difficulty of growing crystals of any reasonable thickness. The molecules have therefore a much greater tendency to link up side by side than end to end so that, in the actual process of crystal buliding, the first step would appear to be the formation of a layer of molecules standing side by side and then, later, would come the end to end junction and final adjustments to give the complete crystal.

When we compare the results of such X-ray work with those obtained by a study of thin films, we see immediately that there is a close relation between the type of orientation found in molecular aggregates other that solids and that which is the principal characteristic of the crystal. The study of films of these long chain compounds shows that they very readily form layers in which the molecules are arranged side by side, parallel to one another. Adam's measurements of the cross-section of the molecules in close-packed films agree with those determined by X-ray work.

We have seen that the habit of the crystal suggests that this side by side arrangement would be the first step in the formation of the crystal, and it is, therefore, natural that in these films, which may perhaps justifiably be considered as insipient crystals, this particular orientation would be the one selected.

The double and single layers which we find in these long chain crystals have probably a considerable bearing on the possibility of the formation of oriented films. Speaking generally, it would appear that those substances which form into crystals with double molecular layers are those which readily give rise to highly oriented films. The film, say, of stearic acid on water although of monomolecular thickness should probably rather be considered as a double layer of oriented molecules, the one layer being acid, the other water, with their active groups oriented towards one another.

X-ray examination, coupled with a study of the habits of the crystal, shows that, in cases where a double layer is formed, the outer ends of the double layer are always the inactive groups. In the case of a crystal of stearic acid, for example, the groups which appear on any cleavage plane of the crystal are CH_3 and never carboxyl groups. This fact seems to be of some significance in connection with some of Hardy's lubrication experiments. He suggests that, in the limiting case, there is between the two surfacse a double layer of molecules, one layer being attached to each surface and the sliding taking place between the two layers. It seems rather improbable that a set of COOH groups will slide easily over another set so that, if the molecules are standing up from the surfaces, their carboxyl groups must be attached to the surfaces. X-ray measurements, on the other hand, show that the carboxyl groups have a strong tendency to come together. Either, then, the attractions of the various surfaces used in the experiments for the carboxyl group are very much greater than the attractions of the carboxyl groups for one another or the true explanation of the phenomenon is that the type of molecular orientation under the conditions of these experiments is diffierent from that found in the case of films of stearic acid on water.

Even pure liquids give X-ray diffraction patterns with broad bands instead of lines. These bands may be interpreted in various ways, but one not improbable interpretation is that, even in the body of a pure liquid, there exists small groups of oriented molecules.

In short, it appears that we are perhaps justified in assuming that any attempt at orientation is essentially an attempt at crystallisation; the more we learn as to the relative orientation of molecules in the crystal the more expert should be become at predicting under what conditions orientation will occur and, when it occurs, what its nature will be.

THE CHEMICAL SOCIETY.

Thursday, March 3.

The Decomposition of Carbon Monoxide in the Corona due to Alternating Electric Fields. Part II. By R. W. Lunt and R. Venkateswaran.

The Properties of the Chlorides of Sulphur. Part I. Freezing Points. By T. M. Lowry, L. P. McHatton and G. G. Jones.

Samples of sulphur chloride, which have been heated to 100° in sealed tubes in order to bring about a condition of equilibrium, give a freezing point curve which exhibits not only the familar maxima due to the crystallisation of S_2Cl_2 and SCl_4, but also two well-defined breaks which are attributed to the crystallisation of SCl_2 and of a *trisulphur tetrachloride*, S_3Cl_4.

Although an equilibrium-mixture having the composition of sulphur dichloride deposits sulphur tetrachloride on freezing, freshly-prepared mixtures of sulphur monochloride with an over chlorinated sample of sulphur dichloride exhibit a maximum freezing-point at the composition SCl_2, which disappears when the mixture is brought to a condition of equilibrium. This is attributed to a rapid production of sulphur dichloride, followed by a slower process of destruction, perhaps $S_2Cl_2 + SCl_4 = 3\ SCl_2$ and $2\ SCl_2 = S_2Cl_2 + Cl_2$.

Sulphur dichloride has been frozen out from freshly prepared mixtures, prepared as above, and has been recrystallised from light petroleum by cooling the solution with liquid air.

Obituary.

DEATH OF PROFESSER A. W. CROSLEY.

Dr. A. W. Crosley, F.R.S., died on Saturday last, March 5 at the age of 58 after having been in ill-health for a long time. He resigned the office of President of the Chemical Society early in January of last year.

He will be best remembered for his researches in organic chemistry especially on the hydroaromatic substances. He had held Professorships at the Pharmaceutical Society, and at the Universities of Manchester and London and was the Director of Research to the British Cotton Industry Research Association.

From America comes a report of the death of Professor Ira Remsen, formerly of the John Hopkins University, and the founder of the American Chemical Jounral. now merged into the Journal of the American Chemical Society. Professor Remsen was a pioneer in organic chemical research in America.

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

The following papers will be read on Thursday, March 17, at 4.30 p.m.—

W. L. Bragg, F.R.S., and J. West : "The Structure of Certain Silicates."

W. A. Wooster : " The Analysis of Beams of Moving Charged Particles by a Magnetic Field."

J. F. Spencer and E. M. John : " The Magnetic Susceptibility of Some Binary Alloys."

ROYAL INSTITUTION.

Albemarle Street, S.W.1.

Friday, March 18.—Emil Hatschek, F.Inst.P., Lecturer on Colloids, Sir John Cass Technical Institute : " Rigidity and Other Anomalies in Colloidal Solutions."

Tuesdays, March 15 and 22.—George Shearer, D.Sc., M.R.I., of the Davy Faraday Research Laboratory of the Royal Institution : " Rays and the Chemical Molecule."

Thursdays, March 17 and 24.—J. Guild, A.R.C.Sc., F.R.A.S. F.Inst.P., of the National Physical Laboratory : " Colour Measurement and Standardisation."

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London.

Monday, March 14, at 8 p.m.—(Cantor Lecture). G. I. Finch, Imperial College of Science and Technology, " Some Industrial Applications of Electrothermics." Lecture I.

Wednesday, March 16, at 8 p.m.—(Ordinary Meeting.) R. E. Mortimer Wheeler, M.C., L.Litt., F.S.A., Keeper and Secretary of the London Museum, " History by Excavation."

MINERALOGICAL SOCIETY.

Tuesday, March 15, at 5.30.—C. E. Tilley : A Melilite-Spurrite-Ca_2SiO_4 Assemblage from Larne (Antrim).

G. Greenwood : "Rotating Crystal X-ray Photographs."

Dr. G. T. Prior : " Alkaline Rocks from Nimrud Volcano, Armenia."

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, W.C.2.

Thursday, March 17.—Professor W. M. Thornton, O.B.T., D.Sc. : Faraday Lecture on " What is Electricity."

N.E. Centre, Armstrong College, Newcastle-upon-Tyne.—Monday, March 14, at 7 p.m.—F. H. Clough, C.B.E. : " The Stability of Large Power Systems."

ROYAL MICROSCOPICAL SOCIETY.

Conference at Liverpool.

March 29, 30, and 31, 1927.

The Council of the Royal Microscopical Society has accepted invitations from the University and Civic Authorities to hold a Conference at Liverpool on Tuesday, March 29, and following days.

The Right Hon, The Lord Mayor (the Rt. Hon. J. C. Bowring, J.P.), and the Lady Mayoress, will hold a reception at the Town Hall on Tuesday, March 29, from 3.30 to 5.30 p.m., to welcome the delegates and Fellows of the Society.

The Conference will be formally opened by Mr. Hugh R. Rathbone, M.A., LL.D. (Pro-Chancellor), in the Arts Theatre, on Tuesday Evening, March 29, at 8 p.m.

Further particulars next week.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

4,246.—Barratt, S. — Manufacture and storage of phosphine. February 15th.

4,264.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of depolymerisation products from carbohydrates. February 15th.

4,021.—Coles, S. O. Cowper.—Production of caustic soda and silica. February 14th.

4,478.—Haller, P. — Condensation products of arylamines. February 17th.

Specifications Published.

265,641.—Cassella & Co., Ges., L.—Manufacture of new aromatic compounds and of new ryestuffs therefrom.

265,767.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of new monazo dyestuffs.

265,777.—Chemische Fabrik auf Actien (vorm, E. Schering).—Process for the manufacture of organic auromercapto acids and salts thereof.

Abstract Published.

263,779.—Hydrofluosilicic acid. — Moller, W., Reinbek, Wentorf, near Hamburg, and Kreth, W., 18, II Woldsenberg, Hamburg, Germany.

Silicia.—Silicon fluoride is decomposed by water in order to product highly concentrated solutions of hydro-fluosilicic acid in apparatus comprising a horizontal chamber containing the reaction liquor and a rotating spindle provided with discs which dip partially into the liquor. In this manner, cool reaction surfaces are provided and the layer of liquid coming in contact with the gas is kept free from precipitated silicic acid. The latter may be removed by connecting a large settling tank with the lower portion of the reaction chamber. The complete apparatus may comprise a number of independent units and filters. The discs may be slotted and divided into several portions mounted obliquely.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

NONOX.

474,755.—Chemical substances in Class 1, used in the manufacture of india-rubber to prevent oxidation.—British Dyestuffs Corporation, Ltd., 70, Spring Gardens, Manchester. February 23rd.

475,136.—Illustration of rising sun and the words " LITHOTEX PICTORIAL MACHINERY, LTD., for chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives, but not including dyes and not including any goods of a like kind to dyes.—Pictorial Machinery, Limited, 7, Farringdon Road, London, E.C.1. February 23rd.

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Outlines of an ABBREVIATED NOTATION IN CHEMISTRY

ROBERT SAXON, B.Sc., F.C.S.

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THE INTERACTION OF MANGANESE SALTS AND PERMANGANATES. PART II. THE ACTION OF MANGANESE CHLORIDE UPON PERMANGANATES.

By J. G. F. DRUCE

Whilst the interaction of hydrochloric acid on manganese dioxide and on potassium permanganate has been studied very fully, no record has been traced of any study of the interaction of concentrated manganese chloride with solid potassium permanganate.

Dumas in 1827[1] obtained a green gas by the action of fused sodium chloride on a solution of potassium permanganate in concentrated sulphuric acid. The green gas condensed to a liquid at 0° C., and Dumas thought he had obtained manganese heptachloride, $MnCl_7$, but Aschoff showed[2] it to be an oxy-chloride, MnO_3Cl, which he suggested had been produced as follows :—

$$(MnO_3)_2 SO_4 + 2HCl = 2MnO_3Cl + H_2SO_4$$

As mentioned in Part I. (*The Chemical News*, this vol., p. 145, March 11), Gorgeu stated that he had never observed the evolution of chlorine during the interaction of manganese chloride and potassium permanganate. This, however, is contrary to the case for, with concentrated solutions, much chlorine is evolved, accompanied by some other volatile substance which is of a deeper colour. When this gas is passed into sulphurous acid it is readily absorbed. The reaction appears to take place in accordance with the equation :—

$$2 KMnO_4 + 2 MnCl_2 = Cl_2 + 2KCl + MnO_2$$

If the interaction is continued for some time, by warming the reactants (about seven pounds of each), and also passing more sulphur dioxide into the absorbing solution, this latter becomes very strongly acid. When it is distilled, any excess of sulphur dioxide comes off first and is followed by water and aqueous hydrochloric acid of constant boiling point. The residue contains much sulphuric acid and on neutralisation with alkalis gives a dark brown precipitate of hydrated manganese oxide (containing perceptible amounts of dvi-manganese—up to 0.4 per cent. according to a private communication from Prof. Heyrovský).

The object of the study of this interaction was the volatilisation of the dvi-manganese content of both the permanganate and the chloride as a volatile chloride or oxy-chloride and the residue of potassium chloride and manganese dioxide was therefore treated further with either concentrated sulphuric or hydrochloric acid.* When the non-volatile residue was extracted with water and filtered the brown filtrate, on

---

* According to Dolejšek and Heyrovský, (*Chemické Listy*, 1926, xx, 4) ordinary chlorine prepared by the action of hydrochloric acid upon pyrolusite contains appreciable quantities of dvi-manganese as a volatile higher chloride,

concentration, gave either potassium chloride or sulphate together with double salts. In the case of the chloride residues the potassium chloride crystals (second crop) small amounts of manganese (0.3 to 1 per cent.) probably in the form of potassium manganichloride, K_2MnCl_5. This double chloride was not obtained pure from the solutions obtained in the present research, but it has been obtained in repeating the work of earlier investigators.

It had been found some years ago[3] that a double salt of potassium chloride and manganese tetrachloride K_2MnCl_6 was not formed when chlorine was passed into a solution of potassium and manganese chlorides in the manner in which potassium stannichloride is formed. Attempts to isolate crystals of K_2MnCl_6 from the potassium chloride-manganese dioxide residues by the action of first hydrochloric acid and then chlorine were also unsuccessful. This salt has, however, been claimed to have been obtained by Meyer and Best[4] and by Weinland and Dinkelacker[5].

The method of Meyer and Best consisted in warming 5 gr. potassium permanganate with 150 c.c. glacial acetic acid and passing in hydrochloric acid gas. Almost black crystals of K_2MnCl_6 are said to separate out on cooling. On following this method it was found that relatively little salt separated, and on analysis of the drained product dried in a vacuum desiccator it was found to correspond more closely with K_2MnCl_5. Perhaps this shows that K_2MnCl_6 is unstable in air. The mother liquors on standing over solid sodium hydroxide deposited more crystals of K_2MnCl_5, which is present in the solution obtained from the action of hydrochloric acid on the manganese dichloride-potassium permanganate interaction residue.

The K_2MnCl_5 and similar double alkali chlorides with manganese trichloride were also said to result by Weinland and Dinkelacker on passing chlorine into a cooled mixture of manganese dioxide in concentrated hydrochloric acid and adding potassium chloride to the decanted clear liquid.

These authors claim to have obtained K_2MnCl_6 by adding calcium permanganate and potassium chloride to a 40 per cent. hydrochloric acid solution. The dark red crystals so formed were said to be unstable in moist air and they even lose chlorine rapidly in dry air. The analytical results were based upon two titrations involving 2-3 c.c. of a decinormal sodium thiosulphate solution and the formula K_2MnCl_6 rests upon the active chlorine found—10.9 per cent. approaching that required theoretically, *viz.*, 11.4 per cent. No other analytical data are given.

Weinland and Dinkelacker also reported the existence of a compound having the composition, $MnCl_4$, $MnCl_3$, 5 KCl.

Several other investigators have obtained double salts of alkali chlorides with manganese trichloride. Thus Neumann[6] obtained the compound 2 NH_4Cl, $MnCl_3$ from manganese dioxide saturated hydrochloric acid and cooled in ice, by the addition of a concentrated ammonium chloride solution, as violet brown crystals. The potassium salt was said to be obtained similarly.

Rice[7] prepared the salts $MnCl_3$, 2 KCl, H_2O and $MnCl_3$, 2 NH_4Cl, H_2O. His procedure was to make a solution of manganese trichloride from Mn_3O_4 or MnO_2 with hydrochloric acid cooled in ice. The decanted manganese trichloride solution was treated with concentrated ammonium chloride solution drop by drop. After standing, the mass of small dark lustrous crystals which separated out were filtered off on a Gooch crucible, washed with a little hydrochloric acid and dried on a porous tile in a desiccator over soda-lime. Above 100° C. the crystals evolved chlorine. Water at once decomposed them, about half of the manganese present was precipitated as hydrated dioxide and the other remainder in solution as manganese dichloride.

Holmes and Manuel[8] confirmed the opinion that there is no direct evidence of the formation of manganese tetrachloride from manganese dioxide with hydrochloric acid. In their study of this reaction they obtained manganese trichloride as an almost black solid with a faint green tinge. It was very soluble in ether; the alcoholic solution was wine coloured.

Double pryidine and quinoline salts were obtained by Reitzenstein[9] from the mixed hydrochloric acid solutions. He assigned them the formulæ

$$(C_5H_6N)_2\ MnCl_6,\quad (C_9H_9N)_2MnCl_4,\quad \text{and}\quad (C_5H_6N)_2MnCl_4.$$

Meyer and Best (*loc cit.*) also obtained the quinoline and pyridine double chlorides; and from potassium permanganate in acetic acid by the action of concentrated sulphuric acid, they obtained K_2SO_4, $Mn_2(SO)_3$ quantitatively.

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AN ATOMIC MODEL FOR THE CHEMIST.—II.

By FLORENCE LANGWORTHY.

Having built up the atom to the end of one series and the beginning of another, we will now break it down in order to see if the evidence is in favour of our having built it aright. We pictured the undamaged fluorine atom as being of atomic weight 18. We know that if we fire into the atom an electron of a velocity that is dangerous to the atom we get in return for our bombardment an X-ray. The velocity that is dangerous to the atom is proportional to the frequency of the chief planet. In the case of the fluorine atom the chief planet is naturally the fluorine planet; its coronal electrons are those which are nearest in their orbits to the atomic sun. We can understand the dangerous velocity of the electron being thus proportional to the planet's frequency if we bear in mind the structure of our atom. In the sun-atom, for instance, the inner electrons of this double-positive can, by their repulsion, normally keep other electrons at a distance—as we saw the electron-planets are kept. That the coronal electrons have been forced nearer to these inner electrons is due to their having been caught between these two repulsions. For an electron to approach the nucleus, therefore, it must have a velocity that is able to overcome this repulsion, and, even so, it apparently has to make its approach by avoiding the plane of greatest repulsion —that is to say the plane of the ecliptic. The attraction of the double-positive sun will thus give a downward curve to its flight which will last until the inner electrons of the sun-atom come into play and it is repelled into the nearest orbit. If the velocity of the electron is too low it will not be able to overcome the repulsion of the electrons in the atom, four of which, we saw, were added with each major planet and two with each minor planet. It will not, therefore, be able to approach the nucleus. While if the velocity is too high, the atomic sun will not be able to deal with the intruding electron and so it will simply pass on its way. The higher the weight of the atom, however, the less the chance of the electron, for if the atom for instance, is chlorine instead of fluorine and so has two sun-atoms in the atomic sun instead of one, the repulsion due to the inner electrons will be augmented. For though the sun-atom of the first system may have been turned into an atom of yellow inactive helium this inactivity will not prevent it from doing its best to repel any electron that tries to come too near to it.

We will, then, picture the electron of dangerous velocity that is shot into our flourine atom as being repelled into the nearest planetary orbit, that is to say the two orbits of the two coronal electrons belonging to the fluorine planet. The violent repulsion that ensues gives the positive—tugging at its two coronal electrons—its chance to escape with them. In its flight it is not accompanied by the electron-planets that have held it since they belong to the sun atom, and as soon as it is free from them it receives in full all the repulsion of the double-positive sun-atom for a positive planet. So it flies off with its coronal electrons and thus forms an X-ray. For in such a flight we undoubtedly have matter in a ray state. The X-rays are a form of light, and experiment has shown that the cause of light is the joining up of electrons with positives. We shall therefore be right in looking upon the X-ray and the Alpha ray as rays, but not the so-called Beta ray—which is simply an electron—no matter with what

velocity the latter escapes from the radioactive elements. In this case we have an X-ray of short wave-length, since it consists of only a positive particle and two electrons, and so it will come under the K heading. We will now suppose that this K X-ray penetrates an atom. Its frequency will make it most dangerous to a nitrogen or carbon atom for it has been shown that the high absorption coefficients set in at certain definite points and that the most dangerous rays are those, apparently, from a substance that is about two or three places higher in the atomic scale. Zinc X-rays, for instance, are those that are most dangerous to nickel. Our X-ray, then, will be pictured as penetrating a carbon atom. If the latter is in the undamaged state then the X-ray is seemingly absorbed. We can understand that the X-ray will be more acceptable to the inner electrons of the sun-atom than was the intruding electron since it has a positive to modify its negativism. But in spite of that its electrons are repelled into the nearest coronal orbit, though not so violently, only, it would appear, as far as the nearer orbit of the two, and here the two electrons make their two orbits on the repulsion of this electron. Since the wave-length of this X-ray is the best for absorption on the part of the carbon atom we shall understand that this wave-length brings the positive into the proximity of the carbon planet's negative particle so that it can attach itself to it. Thus the carbon planet has gained an isotope, it is a double-positive now instead of being mildly negative as it would be with its negative particle only or a single positive—if it should temporarily lose its negative particle. The carbon planet has lost one electron and gained two and its atomic weight has gone up from twelve to thirteen. In return for our X-ray bombardment a high-speed (coronal) electron has been yielded up, whereas in the previous case an X-ray was yielded up on bombarding the atom with a high-speed electron. We will now suppose that an electron of a velocity dangerous to it is shot into this isotoped carbon atom. The X-ray that is now liberated—an L X-ray—is one of much longer wave-length than the K X-ray that would have left the atom if it had not been isotoped. For then the carbon planet would have consisted simply of its positive particle, its negative particle and its two electrons. But now it has the extra positive and three electrons instead of two. As these electrons have to encircle a much larger primary their frequency is not so high as it was in the case of the K X-ray, although they have come from the same carbon coronal orbit. Even so if we had isotoped our fluorine planet before shooting it out of the atom we should have given the planet an extra positive which it could have held up by means of the two electron-planets and its weight would have gone up from 18 to 19. It would thus have left the atom as an L X-ray, though one of short wave-length.

We might say, then, that every element will yield us a K X-ray if it is in the undamaged condition or an L X-ray if it has been damaged. But matters are not quite so simple. The atomic weights have shown us that there are twin-elements and these twins can apparently be made to leave the atom by means of a high-speed electron as an M X-ray. That is to say the helium atom is not given its chance to form and the twin departs as an X-ray. There are other complications also which must be left until later. As we shall see the presence of twin-elements in the atom has a disturbing effect on the atomic economy. It will be noticed that the systems containing the puzzling rare earths follow upon the sixth system which contains the three twin-elements, cadmium, tin, and tellurium. We must, however, continue in our task of building up the atom before we can destroy it, but before leaving this subject we shall just note the great difference that there is between the departing X-rays and the departing Alpha rays and the departing Beta particles. In the Beta particle we have a pure negative (an electron) and so it can be deflected from its course by the means at our command. In the Alpha ray we have a strong double-positive and so that, too, can be deflected. But in the X-ray as shown above we have a mixture of single positives and electrons and therefore it may well be impossible to deflect it.

IS AMERICA GRADUALLY DRIFTING WESTWARD?

Canada Participates in World-Wide Investigation as to Movements of Continents.

Is America drifting westward? Was it originally one with Europe, Africa and Oceania? Was there at one time only one vast continent, which subsequently broke up, the component parts gradually drifting apart to eventually take up the positions they occupy to-day? If so is this gradual drift still continuing at a rate which can be

measured? These are some of the questions which have been arousing interest in scientific circles for a number of years.

This theory, first set forth in concrete form by Wegener, an Austrian geophysicist, has, in the light of recent knowledge, many points in its favour. It is now, for example, practically an accepted fact that the basaltic sub-stratum underlying the surface crust of the earth is not absolutely rigid and unyielding, subject only to volcanic or tectonic action, as previously believed. The present idea is that all rock susceptible, under the action of long-continued stresse, to gradual deformation, so that the continents may be considered as to all intents and purposes floating on a substratum which, when long periods of time are considered, acts like a semi-viscous fluid. The flow of ice in glaciers is a similar phenomenon.

It is only necessary to examine a map, or better, a terrestrial globe, to see that the outlines of America on the one hand, and Europe on the other, would fit into each other with remarkable precision by a simple displacement. There are also many geological and palaeontological evidences to show that in early times there must have been a much closer association between the forms of plant and animal life existing on these continents. Briefly the theory is that in the progress of ages the Americas have been gradually drifting westward; it is claimed that the existence of a western coast range of mountains extending throughout the whole length of these continents is simply the effect of a buckling or crushing at the forward edge due to this drift; the present rate of the drift is estimated to be of the order of one metre per year.

Partly with a view to testing this hypothesis, an international arrangement was reached by which, during October and November last, some fifty stations distributed among nearly thirty countries were united in a longitudinal net by astronomical observations coupled with radio time-signals. The relative longitudes of these stations havin gbeen once determined, it will be possible by a repetition of the observations at some future date to definitely settle the question of the drift of the continents.

Canada took her part in this investigation by occupying two stations, one at the Dominion Observatory, Ottawa. the other at Vancouver. At the latter place the point selected was a small field observatory which had already been occupied by the Ottawa Observatory a number of years ago for latitude and longtitude observations made for purely Canadian purposes.

At each station two telescopes were in constant use, as well as the usual auxiliary equipment of clocks, chronometers, and wireless instruments. At Vancouver, since the clock equipment was not of the same permanent and concise character as was possible at Ottawa, use was made of a portable gravity pendulum, swinging entirely free and in a vacuum, to serve as a check on the clock. At Ottawa astronomical observations were obtained on thirty-three nights, and at Vancouver on twenty-five. At each place wireless timesignals from five different sending stations were received and measured at all hours of the day and night; the total number of distinct signals received was over thirteen hundred. Observations to determine the relative personal equations of the four observers engaged were made at Ottawa both before and after the main series of observations.

General Notes.

LAND INJURED BY IRRIGATION WITH SEWAGE CONTAINING COPPER.

At the recent meeting on March 2, of the Royal Agricultural Society of England, Dr. Voelker said :—

I was recently asked to analyse the soil of a farm respecting which the complaint was that corn crops, after appearing to be doing well, fell off and withered away. The analysis showed the soil to be, as regards the principal elements of fertility, more than usually well supplied. But, in the course of the analysis, I detected the presence in the soil of compounds of copper, and on determining the amount, I found it to be equivalent to .066 per cent. of copper.

It so happens that, in the course of a long series of investigations conducted at the Woburn Potculture Station, I had, in the years 1913 and 1914, experimented on the influence of compounds of copper upon the wheat crop, and found then that copper salts, if present in quantity exceeding .05 per cent., had a distinctly harmful effect. In the present case I ascertained that the land had, for a number of years previously, been irrigated with the sewage of a manufacturing town, and, no doubt, this had carried copped waste with it, and

the copper had accumulated in the land, now producing the effects complained of.

It is worthy of note that this makes the third instance in which the presence of elements harmful to crops has been traced to sewage irrigation, the previous instance being those of zinc (from galvanising works) and of borax (from borax works). In each case the data for the toxic limits have been established by work carried out at the Woburn Pot-culture Station under the Hills Bequest.

CARNEGIE COAL CONFERENCE.

A second international conference on Bituminous Coal will be held at the Carnegie Institute of Technology in November of 1928 according to an announcement by Dr. Thomas Baker, president of the institution. The statement is contained in recently issued volume of proceedings of the first conference held from 15 to 18, of last year.

"We are so greatly encouraged by the success of the first International conference on Bituminous Coal held at the Carnegie Institute of Technology last year," he states, "that we have definitely decided to hold a second and similar international congress two years from now."

The first conference, which called by President Baker for the purpose of finding new uses for bituminous coal and especially to discuss the problem of liquefying coal to supplement the petroleum oil supply of the world. More than 1,700 delegates including representatives of thirteen different countries attended. The speakers included Dr. Friedrick Bergius and Professor Franz Fischer, who have successfully liquefied coal; General Georges Patart and Jean Bing, of France; Dr. C. H. Lander, Geoffrey M. Gill, Harold Nielson, and Dr. R. Lessing, of England; and several other well known foreign scientists in addition to a long list of prominent American engineers and men of affairs and science.

President Baker stated that the second conference will be planned to uncover whatever new information is made available during the coming two years regarding various problems in the use of soft coal.

SOUTH METROPOLITAN GAS CO. AND NATIONAL HEALTH INSURANCE.

The "all-in" insurance scheme of the South Metropolitan Gas Company, which was referred to at the recent general meeting of the company, is the first contracting-out scheme which has been approved by the Minister of Health under the Act of 1925. In this case it represents the amalgamation of an old superannuation scheme with machinery for providing the normal health and pensions benefits, but as the main difficulty in drafting the scheme has been in respect of the benefits prescribed in the State insurance schemes, the experience of the company on this side will no doubt be valuable to other undertakings.

A PRIESTLEY NUMBER.

The February number of the *American Journal of Chemical Education*, is a Joseph Priestley number. It contains a fairly full history of the life and death of Priestley, with many illustrations including that of his house at which the American Chemical Society was founded, his home at Birmingham, England, and a vivid picture of the destruction of the latter, also the Birmingham statue of Priestley. Among other illustrations is one of his gravestone at Northumberland, Pa., U.S.A.

ROYAL SOCIETY OF ARTS.

The Royal Society of Arts was founded in 1754, and incorporated by Royal Charter in 1847, for the Encouragement of the Arts, Manufactures, and Commerce of the country.

At present the Society numbers about 3,500 Fellows. The annual subscription is three guineas. the life subscription thirty guineas. There is no entrance fee.

TENDERS INVITED.

We are advised by the Department of Overseas Trade that the Acting Commercial Secretary at Santiago, Chile, reports that the Chilean State Railways are inviting tenders for the supply of the following goods required during 1927:—

(Each article described is preceded by its group number, and followed by the date of opening of tenders.)

15.—Asbestos and other packing, rubber hose, etc.—11 April, 1927.

16.—General ironmongery, including hinges, padlocks and other door fittings; emery in powder, emery stones and cloth; steel brushes for foundry use; fire extinguishers; wooden handles for tools, etc.—11th April, 1927.

17.—Acetylene lighting and material for electric and autogenous soldering.—25th April, 1927.

18.—Chemical products, including hydrochloric and sulphuric acids, alcohol, disincrustant (" Dearborn " or similar brand), ferrocyanide of potassium, disinfectant (" Flitt " or similar brand), and " Flitt " disinfecting apparatus.—25th April, 1927.

19.—Lubricating and illuminating oils, grease and waste.—25th April, 1927.

20.—Paints, varnishes and painting utensils.—9th May, 1927.

21.—Iron and steel wires and wire netting.—9th May, 1927.

22.—Metal cables and chains.—9th May, 1927.

23.—Nuts, bolts, rivets and clamps.—23rd May ,1927.

24.—Ingots in antimony, tin, iron and lead and foundry materials.—23rd May, 1927.

25.—Tools in general, including pliers, bits for drills, cutters for locomotive boiler tubes, ratchet braces, diamonds for cutting glass, steel brushes for foundry use, portable forges, screw jacks, wrenches, hammers, shovels, saws, drills, vices, etc.—6th June, 1927.

26.—Looking glasses and windows.—20th June, 1927.

27.—Machinery, including autocars, pumps, " Bouser " and " Tanges "), handwinches (2 metric tons capacity), steam hoists (2 metric tons capacity), travelling cranes (2 metric tons capacity).—20th June, 1927.

28.—Tool steel in bars, rounds, etc., and iron sheets and bars.—4th July, 1927.

29.—Galvanised and black tubes and copper tubing and accessories.—4th July, 1927.

Tenders will be opened at 3 p.m. on the dates indicated, at the Department de Materiales y Almacenes, Estacion Alameda, Santiago. Local representation is desirable and the Department of Overseas Trade is prepared to furnish prospective tenderers who are not represented in Chile, with the names of firms who may be willing to handle tenders on their behalf.

Further particulars of these calls for tenders can be obtained bl firms in a position to offer British materials, on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1., quoting the group number in which they are interested as well as the reference number, C.X.2206.

ROYAL INSTITUTION.

At a general meeting of the Members of the Royal Institution held on March 7, Sir James Crichton Browne, manager and vice-president, in the chair, Mr. J. R. Beard, Lady Biles, Mr. William Blaikley, Professor W. C. Clinton, Miss J. G. Dunlop, Dr. L. G. Glover, Mr. H. H. Hemming, Sir H. Cassie Holden, Mr. James Kewley, Mr. A. J. Makower, Mr. E. L. Marler, Mr. P. W. Rootham, Miss Lucie Simpson and Mr. F. Young were elected Members.

A *Report* on the Fermentation Industries for 1926 has been prepared by Mr. H. Lloyd Hind, B.Sc., F.I.C., for the Society of Chemical Industry, and the Institute of Brewing. In this review of the year's achievements, Mr. Hind deals with the effect of varying hydrogen ion concentration, enzymes, yeast and fermentation, alcohol and bacterial fermentations, starch and its conversion products, nitrogen and beer stability, the preserving power of hops and the mineral constituents of mashing liquor.

RESEARCHES ON TERPENES AND RELATED COMPOUND. III. ISOMERISATION OF SAFROL UNDER REDUCED PRESSURE.

By NENOKICHI HIRAO.

The author obtained a new method of isomerisation with good results, *i.e.*, the isomerisation of safrol under reduced pressure by potassium hydroxide. The results of the studies are briefly summarised as follows :—

1. A mixture of powdered potassium hydroxide (3 parts) and safrol (100 parts) was heated to boiling under the vacumity of 13-18 mm. for 3.5 hours and a good result (94.6 per cent.) of isomerisation was obtained.

2. When the alkali is reduced to 2 parts the mixture must be heated for 5 hours to complete the isomerisation.

3. By the presence of a small amount of water the reaction is retarded, but it can be completed by protracting the time of heating.

4. The isomerisation is unsatisfactory by using sodium hydroxide instead of potassium hydroxide.

5. The reaction is completed without resinification.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday February 10 :—

The Photographic Action of β-Rays. By C. D. Ellis and W. A. Wooster. Communicated by Sir Ernest Rutherford, P.R.S.

The usual way of recording the β-ray spectra of radio-active bodies is by means of a photographic plate, but while this enables the energies of the individual groups to be measured from their position on the plate, the relative intensities cannot be determined until more is known about the law of blackening by β-particles. Previous workers had used heterogenous beams, comprising particles of all velocities, but in this work homogeneous beams separated by magnetic deflection were used.

The reciprocity law is found to hold, and the form of the blackening curve is independent of the time of development and of the velocity of the particles between Hρ 1450 and Hρ 5830. The blackening curve follows a simple empirical formula, which is discussed. The most interesting point is that this formula is identical with that holding for the blackening by X-rays, the constants in the formula showing the same variation with velocity as holds for variation in frequency in the case of X-rays. Full details of method of handling and development are given.

The Relative Intensities of the Groups in the Magnetic β-Ray Spectra of Radium B and Radium C. By C. D. Ellis and W. A. Wooster. Communicated by Sir Ernest Rutherford, P.R.S.

Previous work on β-ray spectra of radioactive bodies has been concerned almost entirely with the energies of the individual groups forming the spectra, but many important questions are connected with relative intensities. These have been measured for RaB and RaC by photometering the photographic plates on which they are recorded in the usual focussing method. A special point is that intensities of the groups in the two spectra are measured on the same scale and refer to equal numbers of disintegrating atoms.

An interesting result is that the ratio of the intensities of the groups due to conversion of the same frequency γ-ray in the K and L levels is found to be independent of the frequency and equal to that occurring in the ordinary external absorption of X-rays. The bearing of this result on the mechanism of emission of the groups is discussed.

Making use of Gurneys determination of the number of electrons in the strong groups of radium B, the number of electrons in all the other groups are deduced. This renders possible direct determination of total number of secondary electrons emitted from these two bodies.

An X-ray Investigation of Certain Long-Chain Compounds. By A. Muller. Communicated by Sir William Bragg, F.R.S.

A few typical representatives of long-chain compounds have been investigated by means of X-rays. The substances were in the form of well developed single crystals.

The Xray examination leads to the conclusion that these substances contain straight carbon chains of identical or very nearly identical zigzag structure. The angle between two lines connecting the centres of three consecutive carbon atoms is little different from the tetrahedral angle (109° 30′). The chains can be represented by rods of elliptical cross-section. In the crystals these rods are packed in bundles or, in other words, with their axes parallel to a fixed direction in the crystal lattice. The density of packing of these rods is the same for all the substances.

A structure factor for crystals of the stearic acid type has been given. This factor accounts for certain very typical features of the X-ray intensity distribution, as shown on the photographs. These particular substances are monoclinic prismatic. The monoclinic angle, which is arbitrary to a certain extent, is chosen such as to measure tilt of chains relative to basal plane. This basal plane is identical with the one well-developed face of these crystals.

Comparisons between X-ray data and others obtained by Langmuir and Adam from measurements of mono-molecular films of long-chain compounds, see mto suggest that the crystal structure and the structure of the compound film are very similar, if not identical. The imperfect crystallisation shown by some of these long-chain compounds has been treated as a side line.

The Straggling of α-Particles from Radium C. By G. H. Briggs. Communicated by Sir Ernest Rutherford, F.R.S.

The straggling of α-particle from radium C is investigated by measuring the variation in velocity by the magnetic deflection method when the rays passed through

various thicknesses of mica. The deflected and undeflected bands produced on a photographic plate are analysed by a microphotometer and results for emergent velocities from 0.98 V_0 to 0.22 V_0. The distribution of energies on emergence is very approximately, as the theory of the phenomenon given by Bohr indicates, Gaussian in form.

From the data for the energy distribution it is shown that the straggling of the ranges can be calculated at any point in the region investigated, and is found to be about 1.4 times that predicted by Bohr. Half the total straggling in range occurs in the first 2.4 cm. of the path. The discrepancy between theory and experiment would be explained if transfers of energy occur twice as often as theory indicates.

GEOLOGICAL SOCIETY.

The following paper was read at the meeting held on February 23 :—

A Critical Revision of the Rugose Corals Described by W. Lonsdale in Murchison's "Silurian System." By WILLIAM DICKSON LANG, M.A., Sc.D., F.G.S., AND STANLEY SMITH, M.A., D.Sc., F.G.S.

ABSTRACT.

The Corals and Polyzoa described and figgured by W. Lonsdale in Murchison's "Silurian System," are important, not only for including the genotypes of several genera and the holotypes of a number of species, but also for being some of the earliest-described British Silurian forms. It is clear, then, that a detailed knowledge of both the external characters and the internal structure of Lonsdale's specimens is desirable, especially in view of their misinterpretation by subsequent authors, who have identified some of them with species to which they are not even closely related. Lonsdale, too, has wrongly referred some of his specimens to species already described by former authors. Consequently, the nomenclature of British Silurian Corals is confused; and it is the object of this paper to unravel the tangles so far as the Rugose Corals are concerned, and to put the nomenclature upon a sound footing. Lonsdale's names for these corals are as follows :—*Astrea ananas* de Blainville; *Caryophyllia flexuosa* Lamark; *Acervularia baltica* Schweigger; *Cyathophyllum turbinatum* Goldfuss; *C. angustum* sp. nov.; *C. cæspitosum* Goldfuss; *C. dianthus* Goldfuss; *Cystiphyllum siluriense* Lonsdale; *C. cylindricum* sp. nov.; *Strombodes plicatum* Ehrenberg; *Turbinolopsisbina* sp .nov.; *T.* sp.; *Cyclolites lenticulata* Lonsdale; *C. præacuta* Lonsdale.

It is fortunate that, although some are lost, many of Lonsdale's specimens still exist, and are now in the Museum of Practical Geology, London. The authors are indebted by Dr. F. L. Kitchin for kindly allowing them to borrow the specimens. Besides Lonsdale's types, certain other Rugose Corals, described by F. M'Coy and by A. M. Edwards and J. Haime, have been examined and are described in this paper. They are allied to those described by Lonsdale and are involved in discussing these. The types are in the Sedgwick Museum, Cambridge, and were kindly lent to the authors by Prof. J. E. Marr for examination. They were originally described under the following names :— *Arachnophyllum typhus* M-Coy; *Strephodes trochiformis* M'Coy; *Cystiphyllum brevilamellatum* M'Coy; and *C. grayi* Edwards and Haime.

During the work, several difficult points in nomenclature have inevitably arisen, especially with regard to the selection of genolectotypes. It is hoped that these difficulties, when presented will evoke discussion.

ANNUAL GENERAL MEETING. (GEOLOGICAL SOCIETY.)

The Annual General Meeting was held on February 18, 1927, the President, Dr. F. A. Buttery, M.A., presiding. After the report was dealt with, the President presented the Wollaston Medal to Professor W. W. Watts.

He said :—" Professor Watts, when some years ago you, as President, handed to me one of the Council's awards, I little thought that I should ever be in the position to return the compliment with accumulated interest. Let me assure you that, among the privileges of this position, there is none that gives or I think could give me greater pleasure. It was forty years ago, among the hills and dales of what Lapworth in his last letter to me called 'dear old Shropshire,' that I first learned to appreciate those qualities which have since enabled you to render to geological science the manifold services for which the Council now awards you its highest distinction, the Wollaston Medal. Of those researches concerning the 'mineral structure of the Earth,' to which the Council also refers, it would be almost impertinent for me to speak. Twice before has a Keeper of the

small scale work; in fact, it has been the policy from time to time to make arrangements for some of the preliminary small scale work to be undertaken in the laboratories of universities and other institutions. The Fuel Research Station is in essence a full sized works in which provision has been made for the adequate investigation of apparatus on a full sized scale, in which it has generally been found convenient so to design plants that their throughput will be in the neighbourhood of 10 tons a day. In order that work might proceed uninterruptedly and at the same time without undue haste, arrangements were made with the South Metropolitan Gas Co., who provided the site at a peppercorn rent, for the sale of such surplus products—tar, ammonia, gas and coke—as might be available. The Station has grown rapidly to meet the needs of dealing with the many specific problems which have been introduced both at home and from all over the Empire, and it now contains full sized units of various types of retorts for high temperature carbonisation, briquetting machinery, water-gas and waste heat recovery plants, steam boilers, gas producers, and gas and oil engines. A full scale washery comprising typical units and a Bergius plant capable of dealing with about 1 ton of coal a day, have recently been added to the equipment. Operations are conducted continuously, night and day, throughout the year, except that in August the experimental work is usually suspended in order to afford the necessary leave to the staff and at the same time put in hand alterations and renovations. It has always been considered essential that the utmost accurasy commensurate with the scale of the work should be attained, and the staff now has no difficulty in obtaining weight balances within about 1 per cent.

In the development of the assay apparatus, which was described in a paper by Gray and King (Fuel Research Board, Technical Paper No. 1, "The Assay of Coal for Carbonisation Purposes"), the following points were taken into account :—

1. That while the scale on which carbonisation is carried out should, from considerations of convenience and speed, be as small as possible, it must be sufficiently large to permit of the separate collection and direct measurement of all the products—tar, water, ammonia, gas and coke—so that a weight balance can be struck by which the whole operation may be checked and the qualities of the products ascertained by chemical or physical tests.

2. That the primary products of carbonisation should be withdrawn from the zone of carbonisation at or near their temperature of formation, in order to minimise "cracking" or other secondary changes resulting from their contact with hot surfaces.

3. That in order that the method may be widely applicable, it is desirable to avoid undue elaboration in the apparatus or the use of materials which are not available in any ordinary chemical laboratory.

A further study of the method of assay, in conjunction with the working of large scale apparatus, has shown that it is possible to forecast with considerable accuracy the behaviour and yield of different coals or coal blends under working conditions.

Early in 1919 low temperature retorts of an intermediats type were put in hand at the Fuel Research Station. The original setting consisted of nine horizontal steel retorts, 9 ft. long and 2 ft. 6 ins. wide. They are constructed of top and bottom plates, which are slightly curved, built of $\frac{3}{8}$ in. mild steel. The sides to which these plates are rivetted are 5 in. channels of standard section.

It is of interest to note that a part of this installation is still in use, and that the retorts after seven years' working have not suffered, and are in just as good condition to-day as when they were put up.

Experiments were conducted both with coking and non-coking coals and with blends of the two, and this installation was used for a thorough investigation of the whole subject of blending in relation to low temperature carbonisation. For a summary of the results obtained reference may be made to the report of the Fuel Research Board for 1920-21. The full logs, while far too voluminous for publication in detail, have been made available to individuals and firms working independently on similar problems. They have been brought along on the present occasion, and can be inspected later by anyone interested.

A comparative study of the results for various coals and coal blends obtained from the assay apparatus and the horizontal steel retorts respectively, enabled further refinements to be introduced into the method of working the assay. As a result such correlationlation factors between the yields can now be obtained that it is possible in the assay to prophesy with considerable accuracy the influence on the large scale of such factors as the proportions of coking and non-coking coal used, and so to determine

the proportions necessary to obtain any particular type of coke. The yield, calorific value and specific gravity of the gas, and the amounts of ammonia and tar can also be predicted. The mean ration of yields

$\frac{\text{Horizontal retorts}}{\text{Assay apparatus}}$ for the various products are approximately as follows :—

Coke	1.0
Tar	0.6
Liquor	1.2
Sulphate	1.0
Gas (cu. ft.)	1.0

The low value of the correlation factor for the tar is of course a measure of the amount of cracking which takes place in these particular retorts. With retorts of other types, for instance, the Freemen retort, tested by the Station staff some little time ago, a correlation factor as high as 0.8 has been obtained for tar.

It would be inadequate to close this lecture without a reference to the tests of plants developed by outside inventors which have been undertaken by the Division. Some two years ago the Division was authorised by the Government to undertake at public expense tests of any plant which claimed to have reached the end of stage 3. Up to the present time, four plants in this category have been investigated, namely, Parker Plant, Barnsley (Low Temperature Carbonisation, Ltd.); Midland Coal Products, Ltd., Netherfield, Nottingham; " Fusion " retort, Fusion Corporation, Ltd., Middlewich, Cheshire; " Freeman " retort, British Oil and Fuel Conservation, Ltd., Willesden.

Since reports on these tests have been published it is unnecessary to go into detail, but it may be stated that the technical claims made for plants by those responsible for their design have in the main been substituted. No attempt, however, has been made by the Division to pronounce upon the commercial possibilities of these plants since it is strongly felt that their prospects are so much affected by local conditions that no reliable pronouncement can be made until after they have reached the end of the fourth of the stages enumerated earlier in this lecture.

RECENT GERMAN SCIENTIFIC PUBLICATIONS.

1. *Der Bau der Atome und das Periodische System*, von PROF. IVAN KOPPEL. Pp. VI, 174. Leipzig : Verlag von Leopold Voss. 1927. Price, 9 marks, unbound; 10 marks 50 pf., bound.

2. *Die Massanalyse*, von DR. I. M. KOLTHOFF unter Mitwirkung, von DR. H. MENZEL. Pp. XII. + 254. Berlin : Julius Springer. 1927. Price, 10 marks 50 pf.

3. *Über die Härte anorganischer Verbindungen und die der Elemente*, von DR. ERNST FRIEDERICH. Pp. 44. Berlin : Gebrüder Borntraeger. 1926. Price, 3 marks 60 pf.

4. *Schwefelsaure, Sulfat u. Salzsaure*, von DR. BRUNO WAESER. Pp. 131. Dresden and Leipzig : Theodor Steinkopff. 1927. Price 7 marks, unbound; 8 marks 20 pf., bound.

5. Prof. Abderhalden's *Handbuch der biologischen Arbeitsmethoden*. Lieferung 211. Abt. I. Chemische Methoden, Teil 11, Heft 2 Verbindungen der Pflanzenwelt, 2. Hälfte. Pp. 71-216. Berlin and Vienna : Urban & Schwarzenberg. 1926. Price 7 marks 20 pf.

6. *Die Automobiltreibmittel des In- und Auslandes*, von DR. ERWIN SEDLACZEK. Pp. x. + 247. Berlin : Julius Springer. 1927. Price, 14 marks 40 pf., bound.

7. *Die Theorie der psychischen Welle*, von J. H. VAN DER CRAB. Pp. 90. Baarn : Hollandia-Drukkerij. 1926. Price 2.25 florins.

The first of the above publications is, like many others issued recently, the outcome of a series of lectures, and is primarily intended for the use of chemists and students who desire to understand the latest views on the structure of the atom and its repercussion on the Periodic Classification of the elements. The author has historically traced the development of our knowledge of the structure of the atom and has selected his material so as to present results and views without the practical details and much of the theoretical reasoning which has accompanied the advances made in this subject. He begins with the development of the Periodic System and the early scientific study of the atom which followed upon the acceptance of Mendelejev's Table. Then comes an account of sub-atomic phenomena together with those associated with the radio-activity manifested by certain elements. The action of alpha particles, the isotopes, X-rays,

optical spectra. extension of the Quantum Theory, and the structure of the shells of the electrons.

The short section on the application of X-rays is largely taken up with an account of German work in connection with the elements of atomic numbers 45 and 75 which it is stated were discovered by X-ray analysis by Noddack, Tacke and Berg. A foot-note (p. 80) mentions that Prandtl has criticised this work, and another one refers to his doubts concerning the recent discovery of 61. Nevertheless, Masurium and Rhenium figure in the Tables and Schemes on pages 31, 143, 161 and 167, and they occur in the subject index. The index of authors omits all these investigators and is otherwise very incomplete. No reference is made to the other researches which have been carried out on this subject, although if the author had read the article of Prandtl which he cites, he must be acquainted with the accounts of this work, which have appeared in *Nature*, *Chemisch Weekblad*, *Chemické Listy* and the *Chemical News*.

A similar tendency to minimise non-German contributions to science is noticeable throughout the book.

2. From the sub-title, "Erster Teil—Die Theoretischen Grundlagen der Massanalyse," and the Preface, it appears that Dr. Kolthoff will shortly publish a volume on practical analytical methods as a companion to the present Massanalyse. His own contributions to analytical chemistry are well-known and the second part will be eagerly awaited.

The basis of the precipitation and neutralisation reactions employed in analytical procedure are considered from the standpoint of physical and chemical theory. Indicators, errors of titration, the effect of the velocity of reactions, adsorption phenomena, retention of the solutions and the saponification of esters in organic chemistry are also discussed.

3. Dr. Friederich has made a study of the hardness of the elements and their solid compounds and in his monograph he shows that there is a definite relationship, or law, comparable with that which has been traced for the melting points and other physical properties. The influence of valency and the structure of the atoms is expressed in his two formulæ. The chief result of these researches is to show that the degree of hardness is attributable to the electrostatic attraction of the ions or atomic lattice in accordance with Coulomb's Law.

4. Dr. Waeser's book (Vol. 12 of Prof. Rassow's Technological Monographs, published by Messrs Steinkopff), gives an interesting account of the main branch of the heavy chemical industry. He traces its history up to the outbreak of the war. This is followed by a brief summary (chiefly statistical) of the industrial development in many countries since 1914. The larger portion of the book is taken up with a description of the sulphuric and hydrochloric acid and salt-cake industries during the last decade. The raw materials, present industrial practice, methods of acid concentration, and recent improvements are all carefully considered with frequent reference to the patent and other literature.

5. The latest section of Prof. Adberhalden's comprehensive *Handbuch* contains two lengthy contributions. Dr. W. Beth, of Kiel, gives an account of the bitter principles to be found in plants belonging to the Natural Orders Gentianaceæ, Compositæ and Labiatæ. These compounds include not only the plant alkaloids (which are not considered in this section) but many lactones, glucosides colouring matters and 'plant products of unknown constitution.' The occurrence, isolation, properties and chemical synthesis of these compounds are fully considered. It should be pointed out that these substances are by no means restricted to the Natural Orders mentioned in Dr. Beth's opening paragraph.

The other contribution to this section deals with recent methods of isolating and detecting porphyrins. These substances can be extracted from blood and from plant leaves and the author describes their characteristic spectroscopical behaviour in mineral acids and in alkaline solutions. Both sections, like the whole *Handbuch*, constitute valuable compilations of the latest knowledge and methods in biochemical technique.

6. There has been such a remarkable development in the motor industry, not only in England and America, but on the continent as well. that the time must soon come when the present sources of fuel will be inadequate. Dr. Sedlaczek has presented the problem so far as the viewpoint of central Europe is concerned and we may well be anticipated by Germany in the matter of opening up new sources of supply of liquid fuel. Dr. Sedlaczek deals exhaustively with the different types of petrol and their composition and suitability.

7. *Die Theroie der Psychischen Welle* is written by a Dutch author and is issued by Dutch publishers. In 1923 Dr. Crab dis-

covered what he terms psychic waves. This discovery has been followed by surprising results which he gives in the hope of attracting the attention he deems that they merit.

J. G F. DRUCE.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

21, Albemarle Street.

Saturday, March 19, at 3 p,m,—" The Alpha Rays and Atomic Structure." By Sir Ernest Rutherford.

Tuesday, March 22, at 5.15 p.m.— " X-Rays and the Chemical Molecule." By Dr. G. Shearer.

Thursday, March 24, at 5.15 p.m.— " Colour Measurement." By Dr. Guild.

Friday, March 25, at 9 p.m.— " Thunder-clouds." By Mr. C. T. R. Wilson.

UNIVERSITY COLLEGE.

Gower Street, London.

Friday, March 18.—Faculty of Laws. Second Term ends.

Wednesday, March 23.—Faculties of Arts, Science, Medical Sciences and Engineering. Second Term ends.

Saturady, March, 26.—Slade School of Fine Art. Second Term ends.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi.

Monday, March 21, at 8 p.m.—(Cantor Lecture.) " Some Applications of Electro-thermics. II." By G. I. Finch, Imperial College of Science and Technology.

Wednesday, March 23, at 8 p.m.—(Ordinary Meeting.) " The Transition of Agriculture." By C. S. Orwin, M.A., Director, Institute for Research in Agricultural Economics, University of Oxford. The Rt. Hon. Lord Bledisloe, K.B.E., will preside.

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Wireless Section.—Monday, March 21, at 3 p.m.—Discussion on Domestic Electric Refrigeration. To be opened by Mr. R. J. Mitchell.

North-Western Centre, 17, Albert Square, Manchester.—Tuesday, March 22, at 7 p.m. " Notes on the 60,000-Volt Underground Network of the Union d'Electricité." By Col. E. Mercier.

East Midland Sub-Centre, at the Technical College, Derby.—Tuesday, March 22, at 6.45 p.m.—" Powdered Fuel." By G. H. Lake.

THE INSTITUTION OF MINING AND METALLURGY.

ANNUAL DINNER, 1927.

The Annual Dinner of the Institution will be held at the Edward VII. Rooms of the Hotel Victoria (Northumberland Avenue, W.C.), on Wednesday, April 6, 1927, at 7.15 for 7.45 p.m.

The chair will be taken by the President, Sir Thomas Holland, K.C.S.I., K.C.I.E., and The Right Hon. L. C. M. S. Amery, M.P., Secretary of State for the Dominions and Colonies, and other distinguished guests will be present. Orders and Decorations will be worn.

Annual General Meeting.—The Annual General Meeting of the Institution will be held on Thursday, April 21, 1927.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

5,398.—Beckett, E. G.—Sulphuro-anhydride compounds. February 25th.

5,330, 5,331.—Boake, Roberts & Co., Ltd., A., and Bloomfield, A. L.—Manufacture of acyl-halides. February 25th.

4,942.—Humphrey, H. A.—Production of methane. February 22nd.

5,251.—I. G. Farbenindustrie Akt.-Ges. —Treatment of crude nitrate of soda. February 24th.

4,796.—Neale, J. — Densiometer and colorometer. February 31st.

Specifications Published.

244,076.—Chemische Fabrik Griesham-Elektron.—Process for the production of methane.

243,758.—Farbwerke Vorm. Meister, Lucius, and Bruning.—Manufacture of azo-dyestuffs and process of dyeing wool therewith.

Abstract Published.

263,845.—Dyes.—I. G. Farbenindustrie Akt.-Ges. — Frankfort-on-Main, Germany.

Oxy- and alkyloxdibenzpyrenequinones. —Bz2-Aroyloxybenzanthrones are treated with acid condensing agents. The oxydibenzpyrenequinons so obtained. dye cotton from the vat in reddish-brown shades not fast to acid; by alkylation they yield products which dye in fast yellow shades. According to examples : (1) Bz2-benzoyloxybenzanthrone is heated with a mixture of aluminium and sodium chlorides. and the 1-oxy-3 : 4 : 8 : 9-dibenzpyrenequinone methylated or ethylated with *p*-toluenesulphonic methyl or ethyl ester in nitrobenzene; (2) the *p*-toluic ester or Bz-2-oxybenzanthrone is similarly treated, and the 1-oxy-3 : 4-methylbenz-8 : 9-benzpyrenequinone alkylated.

Bz-2-Benzoyl and p-*toluoyl-oxybenzanthrones* are obtained from Bz-2-oxybenzanthrone by benzoylation by the Schotten-Baumann method and heating with *p* toluic acid chloride respectively.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

HALOZON.

473,455.—Chemical substances prepared for use in medicine and pharmacy.—James Browning, 33, Penrith Street, Streatham, London, S.W.16. March 2nd.

PETROCINE.

473,566.—Petroleum jelly for use in medicine & pharmacy.—Petroleum Products, Limited, 308, Tower Building, Water Street, Liverpool. March 2nd.

473,731.—Illustration of a shell and the words A.1. Brand for chemical substances prepared for use in medicine and pharmacy, but not including mustard ,preparations of mustary or mustard oil, cod liver oil or preparations thereof, castor oil or soap, and not including any goods of a like kind to any of these excluded goods. — The General Kaputine Syndicate Limited, Kapu-tine Works, Lilley Street, Queen's Road, Manchester. March 2nd.

Thoroughly Competent MINERAL ANALYST with many years' British, Colonial, and Chinese experience buying ores, etc., for leading London firms, desires responsible Appointment (preferably abroad) where technical knowledge combined with commercial experience and strictest integrity are required; unexceptionable references. — Principals (only) reply to Z.H.798, care of Deacon's, Fenchurch Avenue, E.C.3.

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A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES IN CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

LIST OF COMPOUNDS.

This is a list of compounds other than carbonates, sulphates, etc., crystals with sign /. Deliquescent substances are preceded by the sign :, which also separates ions in electrolysis, and follows substances soluble in water. Wherever possible the melting point is put in front of the symbol for the substance, and the boiling point after it. The sign xx means "decomposes," xxx "decomposes easily or violently," and xxxx "decomposes explosively." A number with such sign indicates the temperature at which such takes place. Other symbols will be dealt with as they occur.

GROUP I.

LITHIUM.

186d Li 1200d, 830d LiF/, $LiHF_2$/, 60d :LiCl/ 1300d, 442d :LiBr/, 72d :LiI.3HOH/ 120d, LiCl2HOH/ 1360d, :$LiICl_4$4HOH/, 600d Li_2O/ 600d (this obviously sublimes at 600 degrees centigrade), LiOH, LiOH.HOH/, 2LiOH.HOH/ Li_2O_2, Li_2S, Li_2Se, :LiSH?, 845d Li_2N (only nitride of the alkalis, formed at ordinary temperature synthetically), 375d $LiNH_2$/, Li_2NH xx 600d, LiN_3HOH/ xxxx 200d, Li_2C_2/, Li_6Si_2 xx 600d, 680d LiH/.

SODIUM.

97.6d Na/ 883d, 980d NaF/, $NaHF_2$/ 800d NaCl/ 1490d, 760d :NaCl2HOH/, :$Na_2ZnCl_4$3HOH/, 765d NaBr/ 1455d, NaBr2HOH/, 650d NaI/, NaI.2HOH/, :$Na_2ZnI_4$3HOH/, $NaICl_4$2HOH/ xx, 400d xx Na_2O/, Na_2O_2 Na_3O, NaO_3? Na_2S/, 445d Na_2S_2/, Na_2S_5, :Na_2Se, Na_2Se_4, Na_2Te, Na_2Te_3, 310d :NaOH/ xx 1500, 64d NaOHHOH/, 12d NaOH2HOH/, 6d 2NaOH7HOH/, all dydrates xx at 10d, NaOOH xx, Na_2S9HOH/, 445d $Na_2S_2$3HOH/, $Na_2S_2$5HOH/, $Na_2S_5$7HOH/, :NaSH, 22d NaSH3HOH/ xx, NaN_3/, 210d $NaNH_2$/ xx 600d, Na_3P, Na_2P_5, Na_3As/, 776d Na_3Bi/, Na_3AsNH_3/, 350d $NaHg_2$/, $NaHg_4$/, Na_2C_2, $Na_2(CO)_2$ xxxx, 380d NaH/ 380d.

POTASSIUM.

62.5d K/57.5d, 885d :KF/, :KF2HOH/, :KHF_2/, :KH_2F_3/, :KH_3F_4/, 772d KCl5 1500d, 745d KBr/ 1435d, 690d KI/, 45d :KI_3/, $KICl_2$/, $KIBr_2$ xxx, K_2O/ xx 400d, K_2O_2, (O(280d K_2O_4/)) (melts at 280 in oxygen), :K_2O_4 xx, 360d KOH/, 143d KOHHOH/, 35.5d KOH2HOH/, 2KOH5HOH, 2KOH9HOH -32.7d KOH4HOH/, K_2S/, K_2S 2HOH, 60d K_2S5HOH/, K_2SI2HOH, 471d K_2S_2/, $K_2S_2C_2H_5OH$/, K_2S_3?, K_2S_4?, K_2S_5, $K_2S_5$8HOH/, 455d KSH, KN_3 xx, no nitride, 338d KNH_2/ 400d xx, KP_x, KSeP, K_2Se/, K_2Se9HOH/, K_2Te/, K_2C_2, $K_2C_2C_2H_2$/, $K_2(CO)_2$, K_2Hg, 178d KHg/, 240d KHg_3/, 188d $NaKHg_2$/, KH/.

AMMONIUM.

NH_4F/ xx, :NH_4HF_2/, double fluorides with Cr, Mn, Fe, Co, Ni, Cu Be, Mg, Cd, Zn, Si, Ti, Sn, Zr, Sb, Bi, Cb, CbO, Ta, TaO, Mo, MoO, NH_4Cl/ xx, NH_4Br/ xx, NH_4I/ xx ,NH_4Br_2I/, double haloid salts with practically every metal, NH_4I_2, NH_4I_3/, $(NH_4)_2S$/, NH_4HS, $(NH_4)_2S_2$ (known only in solution) $(NH_4)_2S_5$, $(NH_4)_2S_7$ (most stable member), $(NH_4)_2Se$, NH_4HSe, NH_4HTe, NH_4xHg (froth), NH_4N_3 xxx, NH_4Br_3 xxx.

HYDRAZINE.

$N_2H_4$2HF, 89d N_2H_4HCl/, 80d N_2H_4HBr/, 127d :$N_2H_4$2HI/, 198d $N_2H_4$2HCl/, 195d $N_2H_4$2HBr/, 220d :$N_2H_4$2HI/, N_2H_4HOH all these are easily decomposed.

HYDROXYLAMINE.

NH_2OHHCl/, $(NH_2OH)_2HCl$/, 95d xx $(NH_2OH)_3$2HCl/, all xxx when heated, NH_2OH probably does not exist in free state.

RUBIDIUM.

38.5d Rb/696d, 753d RbF/, 2RbF3HOH/, 714dRbCl/, 683d RbBr/, $RbBr_3$, 642d RbI/, RbI_3, $RbClBr_2$, $RbCl_2Br$, RbClBrI, $RbBr_2I$, 250d Rb_2O/, Rb_2O_2/, Rb_2O_3, 650d Rb_2O_4, 301d RbOH/, :Rb_2S/, Rb_2S 4HOH, 420d Rb_2S_2 850d, Rb_2S_2HOH/, $Rb_2S_4$2HOH, Rb_2S_5, 287d $RbNH_2$, $RbHg_2$, $RbHg_4$, RbH/, (vac(300d RbH)) (melts at 300 degrees centigrade in vacuo).

CAESIUM.

26.5d Cs/ 670d, 715d CsF/, $CsHF_2$/, 647d :CsCl/, CsBr/ $CsBr_3$, $CcBr_5$? xxx, 621l CsI/, CsI_3, CsI_5 ?, CsI_9 at 25d but n.i. (not isolated), $CsCl_4I$, $CiCl_2I$, double halide salts with Mg, Zn, Cu, Mn, Ni, Hg, etc., 500d Cs_2O/, Cs_2O_2, Cs_2O_3, Cs_2O_4/, (O(600d Rb_2O_4, 515d Cs_2O_4)) (in oxygen), 272d CsOH/, Cs_2S/, 460d Cs_2S_2 800d, Cs_2S_5, $CsNH_2$/, CsN_3 xxx, CsC_2/, $CsHg_2$, $CsHg_4$, CsH/.

COPPER.

1083d Cu/ 2310d, 1200d CuF/ 1200d (sublimes at 1200), 434d CuCl/ 1000d, 450d CuBr/ 900d, 628d CuI/, :CuClNOCl xx, $CuClNH_3$/, CuCl2KCl/, $CuI2NH_3$/, $2CuIHgI_2$?, Cu_2O/ xx, Cu_2OxHOH, 1130d Cu_2S/, Cu_2Se/, Cu_2Te/, Cu_2NH/, Cu_3N, $CuNK_2$3NH_3/ xx 300d, CuN_3/ xx, Cu_3P/, Cu_3As/, Cu_2C_2, CuCN/, Cu_4Si, 920d Cu_2Bt, 797d Cu_2Mg, 905d Cu_2Zn, Cu_2Cd/, CuH, from which it will be seen that copper has strong claims to be regarded as monal, CuF_2/, $CuF_2$2HOH/. x100d $CuF_2$5HF5HOH/ (begins to decompose at 100), :$CuCl_2$, $CuCl_2HOH$, xx 344d :$CuCl_2$2HOH/, :$CuBr_2$/, these are not easy to get and the iodide has not been isolated, $CuCl_2$2KCl/, $CuCl_2$2KCl 4HOH/, also other alkalis, $CuCl_2$2NH_3/ xx, Cu_2O_3, xx 6d CuO_2/, :$CuO4NH_3$6HOH/ xx, $Cu(OH)_2$, CuS/, Cu_2S_3, Cu_2S_5, CuSe/, CuTe/, Cu_2Te_3 xx, Cu_3P_2, Cu_3As_2, Cu_6As, Cu_9As/, CuC_2 Cu_3B_2, 1206d $CuBe_3$, 570d $CuMg_2$, 830d Cu_2Zn_3, 560d Cu_2Cd_3, CuH_2.

SILVER.

960d Ag/ 2000d, Ag_2F/ xx, :AgF, :AgFHOH/ xx, :AgF2HOH/, 460d AgCl/, 426d AgBr/, 550d AgI/, :AgFxHF, $AgCl3NH_3$/, $AgBrxNH_3$, $AgI2NH_3$, AgIHI/ xxx, xx 250d Ag_2O, xx 100d Ag_2O_2/, 676d Ag_2S/xx 950d, Ag_2Se/, Ag_2Te/, Ag_3N xxx, AgN_3 xxx, Ag_4P_6, AgP_2, Ag_2Sb/, Ag_4C, Ag_2C_2, AgOH only at -40d, 820d AgMg, 492 $AgMg_2$.

GOLD.

1064d Au/, AuF_3 xx, AuCl, Au_2Cl_4, :$AuCl_3$/, $HAuCl_4$/, $AuCl_32HOH$/, Au_2Br_4, $AuBr_3$, AuI, AuI_3, Au_2O, Au_2O_3, $Au(OH)_3$, $3Au_2O_22HOH$, Au_2S, Au_2S_3, Au_2Se_3, Au_2Te_3 ?, Au_4P_6, AuAs, Au_2Bi/, Au_2C_2.

As most substances which crystallise do so from solution or the liquid state, those which are insoluble or easily decomposed by heat are not met with in the crystalline state. For this reason sodium salts are mostly crystalline, and those of gold not so. In nature, minerals have been produced under pressure which we cannot command, or have crystallised from the solid through a state of crystalloid stress as in flint, in the same way as vitreous lava becomes obsidian and nepheline or other granite minerals. This has taken ages which we cannot have at our disposal. The usual method of getting crystalline form is by fusion and sudden cooling or by sublimation, and this is obviously impossible with refractory or unstable compounds.

GROUP II.

BERYLLIUM.

Be/, 1300d Be 1530d, 800d BeF_2/800d, 500d $BeCl_2$/520d, 500d $BeBr_2$/ 500d, 510d BeI_2/ xx 590d, 2450d BeO/ 3900d, $Be(OH)_2$, 283d $Be_4O(C_2H_3O_2)_6$ 331d, eSe ?, BeS xx, Be_3N_2, BeP_x, $2BeI_23NH_3$/, Be_2C, 1206d Be_3Cu, 920d $BeCu_3$, BeO_2Na_2, :BeO_2K_2, K_4BeF_4.

MAGNESIUM.

Mg/, 700d Mg 1100d, MgF_2/, 708d :$MgCl_2$/, :$MgCl_26HOH$/, 695d :$MgBr_2$/, 155d, :$MgBr_26HOH$/, 700d :MgI_2/, MgI_26HOH/, 2600d MgO/ 3600d, MgS/, Mg_2OCl_2, Mg_2OS ?, $Mg(SH)_2$, $MgCl_24NH_3$/, Mg_3N_2, Mg_3P_2, Mg_3As_2, Mg_3Sb_2, Mg_3Bi_2, MgC, 961d Mg_3Sb_2, 715d Mg_3Bi_2, $MgC_2C_2H_55NH_3$/, Mg_5SI_3, Mg_3Be, 570d Mg_2Cu, 797d $MgCu_2$, 492d Mg_3Ag, 820d MgAg, 790d MgAu, 1155d MgAu.

ZINC.

Zn/ 418d Zn 916d, 734d ZnF_2/800d, 270d $ZnCl_2$/ 715d, 390d $ZnBr_2$/ 696d, 440d ZnI_2/, ZnF_24HOH/, $ZnCl_2C_2H_5OH$/, $ZnCl_2NH_3$/, $ZnCl_26NH_3$, $ZnCl_22NH_3HOH$/, $ZnBr_22NH_3$/, ZnI_24NH_3/, 1260d ZnO/ 1600+, $Zn(OH)_2$, 1500d ZnS/ 1500d, $Zn(SH)_2$, ZnSe/, Zn_3N_2 xx, ZnP, Zn_3P_2, ZnSb/, Zn_3Sb_2, Zn_2C, $Zn(NH_3)_2$.

CADMIUM.

Cd/, 321d Cd 720d, 550d CdF_2/1200d+, 560d $CdCl_2$/ 890d, 575d $CdBr_2$/ 810d, 380d CdI_2/ xx, $CdCl_26NH_3$, $CdCl_22NH_3$/, $CdBr_22NH_3$/, $CdI_2H13HOH$/, Cd_4O, Cd_2O ?, CdO/, CdS/, CdS_5, CdSe/, CdTe/, $Cd(OH)_2$, Cd_3P_2/, Cd_3Sb_2/, CdSb/, Cd_3As ?, 541d Cd_2Li, 505d CdLi, 564d Cd_3Cu_2, $CdCu_2$/.

MERCURY.

Hg/, -39d Hg 350d, 645d HgF_2/650d, 260d xx HgF/ 260d xx (sublimes at 260 but decomposes), 275d $HgCl_2$/ 300d, 302d HgCl/, 230d $HgBr_2$/ 325d, 230d HgI_2/ 351d, 290d HgI/, $HgCl_24HgO$/, NH_4HgCl_3HOH/, $HgBr_2HgO$/, also 2, 3, 4HgO, $HgBr_22NH_3$, $CuHgBr_44NH_3$/, Hg_4I_6, xx Hg_2O, xx HgO/, (both decompose on heating), (120 atm.(1450d HgS/)), (melts at 1450 under 120 atmospheres), HgSe/, HgTe/, Hg_3N_2, Hg_3P_2, Hg_4Na/, 204d Hg_3K/, 350d Hg_2K/, 178d HgK/, HgK_2/, 188d Hg_2NaK, Hg_4Rb, Hg_2Rb, Hg_4Cs, Hg_2Cs.

GROUP II.—ALKALINE EARTHS.

CALCIUM.

800d Ca 800d, 1300d CaF_2/, $CaF_2 2HF$/, CaF/, CaCl, 780d :$CaCl_2$/, 30.2d :$CaCl_2 6HOH$/, $CaCl_2 8NH_3$/, CaBr/, 765d :$CaBr_2$/, $CaBr_2 6HOH$/, $CaBr_2 6NH_3$/, CaI/, 740d :CaI_2/, 1900d CaO/, CaO_2, $CaO_2 8HOH$/, CaS/, $CaS_2 3HOH$/, $Ca(OH)_2$, $Ca(SH)_2$ $Ca(SH)_2 6HOH$, Ca(SH)(OH), CaS_5, CaSe/, Ca_3N_2, Ca_3P_2/, Ca_3As_2/ $Ca(NH_2)_2$, 2000d+ CaC_2/, $CaSi_2$/, CaB_6/, CaH_2/, $Ca(OCH_3)_2$, $Ca(OC_2H_5)_2$ etc.

STRONTIUM.

800d Sr/ 950d, 1300d SrF_2/, 860d :$SrCl_2$, $SrCl_2 6HOH$/, 620d $SrBr_2$, $SrBr_2 6HOH$/, 402d SrI_2, $SrCl_2 ICl_3 8HOH$/, 300d SrO/, $Sr(OH)_2$, SrO_2, $SrO_2 8HOH$/, $Sr(OH)_2 8HOH$/, SrS/, SrSe/, Sr_3N_2, Sr_3P_2, Sr_3As_2, $Sr(N_3)_2$, $SrSi_2$?, SrB_6/, $Sr(NH_2)_2$, SrH_2/.

BARIUM.

850d Ba 1150d, 1280d BaF_2/, 960d $BaCl_2$/, BaClF/, $BaCl_2 2HOH$/, $BaNaCl_3$/ and others, 880d $BaBr_2$, 740d BaI_2, $BaBr_2 2HOH$/, $BaI_2 2HOH$/, :$BaZnCl_4 4HOH$/, :$BaI_2 2ZnI_2$/, Ba_2O, 2000d BaO/, BaO_2, $Ba(OH)_2$, 77.9d $Ba(OH)_2 8HOH$/, N.B. $CaO_2 8HOH$/ Sr - / Ba - / (meaning t hat all three salts are isomorphous with corresponding formulæ), BaS/, BaS_4/, $Ba(SH)_2$, xx50d $Ba(SH)_2 4HOH$/, BaSe/, 1000d $Ba_3N_2$1000d, BaP_2, $Ba(N_3)_2$/ xxxx 217d (explodes at 217), 1200d BaH_2/ 1400d.

General Notes.

BI-CENTENARY OF SIR ISAAC NEWTON.

On 19 instant (Saturday last) a distinguished company of scientists met at Grantham, the birthplace of Sir Isaac Newton, to do honour to the undying memory of the great scientist.

The Secretary of the Royal Society, Dr. J. H. Jeans, delivered an address, in the course of which he said :— " We are met to do homage to the memory of one who was certainly the greatest man of science, and perhaps the greatest intellect, the human race has seen. We can claim this position for him without arrogance; it is accorded him not only by his own countrymen and co-workers in science, but by those most capable of forming an unbiassed judgment. Laplace considered that the " Principia," had assured to it for all time ' a pre-eminence above all other productions of the human intellect.' Lagrange used similar terms, describing the ' Principia ' as ' the greatest production of the human mind,' and confessing himself dazed at such an illustration of what man's intellect could achieve. He added that Newton was not only the greatest genius that had existed, but also the most fortunate, for as there is but one universe, it can but happen to one man in the world's history to be the interpreter of its laws. Voltaire wrote of him that ' If all the geniuses of the universe were assembled, he should lead the band.'

As British men of science, we may rejoice that this greatest of all men of science was British."

BRITISH IRON AND STEEL IN FEBRUARY.

At the end of February there were 162 furnaces in blast, a net increase of 10 as compared with the beginning of the month. The output of pig iron and steel ingots and castings totalled 567,900 and 819,100 tons as against 434,600 and 730,700 tons respectively in January.

MOULDED STONE SWITCHGEAR CELLS AND CUBICLES.

The British Engineering Standards Association have recently issued a specification for switchgear cells and cubicles constructed of moulded stone (B.S. Specification No. 268-1926.) The specification is divided into two parts indicating the principles to be followed in the construction of : (1) Cubicles constructed from pre-cast units, and (2) cubicles constructed in place. It defines the terms " concrete," " slabs," and " mouldings," and indicates the materials to be employed and method of mixing in the preparation of " concrete." It defines the finish

of "slabs" and "mouldings," and lays down acceptance tests to be made at periods from four to twelve weeks in the age of the slabs. In the case of mouldings, tests are to be taken on slabs taken from the same mix as the mouldings. The tests consist of the application of an evenly distributed load on a central area, the width of the slabs and parallel to the ends where they are freely supported. The specification indicates the general principles to be followed in the design of cubicles.

Copies of this new specification may be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria Street, London, S.W.1.

NEW ZEALAND'S ELECTRICAL AND RAILWAY NEEDS.

The New Zealand Government, which has been placing heavy orders in the United Kingdom recently for electrical, railway and other plant, is again in the market for six electric locomotives, large quantities of locomotive workshop material, and material for the electrification of the railway tunnel between the Port of Lyttelton and Christchurch. The New Zealand High Commissioner in London, Sir James Parr, has reported the receipt of details of these requirements, with the authority to obtain tenders from British manufacturers. In the aggregate the orders will run into a very considerable sum of money.

Manufacturers can obtain full particulars of all these requirements from the High Commissioner for New Zealand, 415, Strand, London, W.C.2.

BRITISH SHIPPING IN 1926.

Net tonnage of vessels that entered and cleared with cargo and in ballast at ports of the United Kingdom from and to other countries last year amounted to 82,278,000 tons and 82,608,000 tons, as against 84,018,000 tons and 85,290 tons respectively in 1925.

UNITED STATES LEATHER EXPORTS.

A decline of about 10 per cent. was recorded last year in exports of leather goods as compared with 1925. Leather footwear and leather belting represented 71 per cent., and 10.7 per cent. respectively of the total export. Particulars of the leading markets for these two commodities are given.

MARINE AND BILSTHORPE COLLIERY DISASTERS.

Under the powers conferred by Section 83 of the Coal Mines Act, 1911, the Secretary for Mines has directed Mr. Henry Walker, C.B.E., H.M. Chief Inspector of Mines, to hold formal investigations into the causes and circumstances of the explosion which occurred on 1 March, 1927, in the Marine Colliery, Cwm, Monmouthshire, and of the accident on the same date in the Bilsthorpe Colliery, Nottinghamshire.

The times and places of these investigations will be announced later.

SAFEGUARDING OF KEY INDUSTRIES.

Ammonium Perchlorate and Potassium Guaicol Sulphonate.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding the following articles :—

Ammonium perchlorate.
Potassium guaiacol sulphonate.

Section 10 (5) of the Finance Act, 1926, is as follows :—"The Treasury may by order exempt from the duty imposed by Section I. of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the the order, any article in respect which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any person desiring to communicate with the Board of Trade with respect to the above-mentioned applications should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, London, S.W.1, within two months from the date of this notice (9th March, 1927).

TOBACCO TRADE EMPLOYEES IN GREAT BRITAIN.

The average number of persons employed in the Tobacco Industry during the year 1924 was 38,802, of which 34,219 consisted of Operative Staff and 4,583 were employed in work of management or as technical

and clerical staff. In 1907 the average number of wage-earners employed was 33,880, and 3,768 other persons were employed in management, clerical and other work. These figures include the numbers employed in Ireland in 1907.

BOARD FOR MINING EXAMINATIONS.

Examinations for First and Second Class Certificates of Competency as Managers and Under-Managers of Mines will be held on May 25 and 26, 1927, at Edinburgh, Newcastle-upon-Tyne, Sheffield, Wigan, Cardiff and Birmingham.

The written part of an Examination for Certificates of Qualification as Surveyors of Mines will be held at the same Centres on May 26, 1927.

Applications for the necessary forms should be made not later than April 11, 1927. In order that the appropriate forms may be sent, it is important that candidates should say whether they have sat at one or more of the Board's Examinations.

Letters should be addressed to the Secretary, Board for Mining Examinations, Mines Department, Dean Stanley Street, Millbank, London, S.W.1.

MERCANTILE MARINE DEPARTMENT.

Board of Trade Engineers and Ship Surveyors.

A competitive examination for one or more appointments as Engineer and Ship Surveyor under the Board of Trade will be held in London on 31st May next. The limits of age are from 25 to 40 years. The salary of these posts is from £300-£500, plus bonus, which is at present £140 on a salary of £300. Every candidate must possess either an extra First Class (Board of Trade) Certificate of Competency as Engineer, or a First Class (Board of Trade) Certificate of Competency as Engineer together with a B.Sc. (Engineering) or other equivalent voucher of scholarship.

Applications should be made on special forms to be obtained from the Senior Staff Officer, Establishment Department (Mercantile Marine Branch), 20, Great Smith Street, London, S.W.1. The last date for the receipt of completed application forms i the receipt of completed application forms is April 14.

BIG YEAR FOR PORTLAND CANAL MINES.

Important developments are taking place in the Portland Canal mining district of British Columbia, and from all appearance this year will see the largest development programme yet carried out. The district produces gold, silver and copper with some lead and zinc. Last year, in addition to the Premier mine, which has operated for a number of years and since 1921 has paid over $10,000,000 in dividends, there were other shippers of high-frade ore, the principal ones being the British-Canadian Silver Corporation, Dunwell Mines and the Porter-Idaho Mining Company. Developments taking place on these and other properties in the district appear destined ultimately greatly to increase the output of the area.

A HUNDRED MINING OPERATIONS IN ROUYN.

The coming summer will see over a hundred mining operations working actively in the Rouyn field, in the opinion of the Toronto *Financial Post*, which has made a comprehensive review of operations under way and in prospect in this north-western Quebec copper-gold area. It will be the first summer in which Rouyn has enjoyed the benefits of rail transportation. The field covers such a wide area that transportation of mining equipment and supplies from the new Canadian National Railway line to the properties is a big undertaking, and there is a rush on to take advantage of winter haulage conditions.

45,000,000 BACTERIA IN A SALT-SPOON OF SOIL.

Investigation into the infinitely minute is revealing a world, outside the range of our natural perception, teeming with boundless and mysterious activity. Scientific research has shown that the soil ,seemingly so inert and lifeless, is in fact the habitation of countless organisms endowed with enormous energy. Some are visible under a powerful microscope; others are so minute that we can never hope to see them. There are four chief groups, *viz.*, bacteria, fungi, algæ and protozoa. The bacteria are the smallest, being from 1/20,000 to 1/50,000 inch in length, and the protozoa are the largest, being 1/25,000 inch long. There are 45 million bacteria in one gram—equal to about a salt-spoonful—of soil, in addition to smaller numbers of other organisms. This congested population is found in every sample of soil yet examined, with the exception, Sir John Russell states, of one from an Egyptian tomb which for over 3,000 years had been unopened. Truly, the romance of research is as fascinating as it is marvellous.—*Sir Henry Rew, K.C.B.*

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

Thursday, March 17.

Tetrachloro - (triaminopropane -mono-hydrochloride)-platinum, a New Type of Optically Active Complex Salt. By F. G. MANN.

In tetrachloro- (triaminopropane mono-hydrochloride)-platinum, the platinum is co-ordinated to four chlorine atoms and to two of the three amino-groups of the tri-amino-groups of the triaminopropane molecule, the third amino-group being thus free for normal salt formation with acids. Hence, although the complex itself is neutral and non-ionic, the compound in aqueous solution furnishes one chlorine ion. Such a compound might exist in two isomeric forms, the platinum being co-ordinated either to the $\alpha\beta$-diamino groups (I) or to the $\alpha\gamma$-diamino-groups (II).

$$[Cl_4\ Pt\ NH_2.CH_2.CH(NH_2).CH_2.NH_2,HCl]$$
I.

$$[Cl_4\ Pt\ NH_2.CH_2.CH(NH_2,HCl).CH_2.NH_2]$$
II.

In the former compound, assymmetry is induced in the central carbon atom of the triaminopropane molecule by the disposition of the co-ordination linking, since this atom thus becomes linked to an aminomethyl group on one side and to a methylene ammonium radical on the other. This compound should therefore be capable of resolution into optically active forms, whilst the isomeric compound (II) should not be so resolvable.

Fractional recrystallisation of the camphorsulphonates has given the optically pure *l*-base-*d*-sulphonate and *d*-base-*l*-sulphonate, which in turn have furnished the *l*- and *d*-monohydrochlorides. The compound is therefore the γ-monohydrochloride.

The Activation of Wood Charcoal by Progressive Oxidation, in Relation to Bulk Density and Iodine Adsorption. By A. B. P. PAGE.

The difficulty of preparing charcoal with definite adsorptive properties has always prevented a satisfactory study of the change of activation with conditions of heat treatment. In this work, great care was taken to make a large quantity of wood charcoal of uniform quality. This standard charcoal was oxidised under accurately controlled conditions of temperature, time of treatment, and composition and rate of passage of the mixture of oxygen and nitrogen used in the oxidation. The bulk density of the treated charcoal was determined, and its capacity for removing iodine for each charcoal and the Freundlich constants evaluated. At most temperatures, the bulk density falls off smoothly with increasing oxidation. The variation of the two Freundlich constants is seciprocal. The exponent decreases and then increases rapidly with increasing oxidation, subsequently showing a much slower decrease. It is suggested that the rapid changes correspond with a change in the effective number of attracting centres per unit of charcoal surface, whilst the slow change corresponds with the increase of surface per gram of charcoal, indiated also by the bulk density curves.

The Parachor and Chemical Constitution. Part V. Evidence for the Existence of Singlet Linkings in Phosphorus and Antimony Pentachlorides. By S. SUGDEN.

The parachors of phosphorus and antimony pentachlorides are lower than the sum of the atomic constants by 26 units. Since the additive nature of the parachor has been verified for a large number of substances, this is taken to mean that the pentachlorides possess a type of linking which has not been met with in the compounds previously studied.

From a discussion of electron valency formulæ and the effect of the number of electrons in a linking on the structural constants for unsaturated linkings, it is concluded that these compounds contain two singlet linkings, each consisting of one electron held in common by two atoms.

The electronic theory of valency is extended to include linkings composed of an odd number of shared electrons, and is applied to the formulation of higher halides, co-ordination compounds, and "molecular" compounds for which, hitherto, it has not been possible to write electronic formulæ without violating the octet rule.

THE INSTITUTE OF METALS.

Synopses of papers presented at the Annual General Meeting, March 9-10, 1927.

Investigation of the Effects of Impurities on Copper. Part V. The Effect of Bismuth on Copper. By PROF. D. HANSON, D.Sc. Member, AND GRACE W. FORD, B.Sc., Member.

This paper describes experiments made on copper containing up to 0.1 per cent. of bismuth on the casting, hot- and cold-rolling, mechanical properties, electrical conductivity, and microstructure of copper.

The experiments confirm the great embrittling effect of bismuth, and indicate that when more than a trace of bismuth alone is present in copper, the working properties, particularly the cold-working properties, are seriously affected. The solid solubility of bismuth in copper has also been investigated.

Investigation of the Effects of Impurities on Copper. Part III. The Effect of Arsenic on Copper. Part IV. The Effect of Arsenic plus Oxygen on Copper. By Prof. D. Hanson, D.Sc., Member, and C. B. Marryat, B.Sc., Member.

These sections describe investigations into the effects of arsenic alone, and of arsenic plus oxygen on copper. The tests described in Part III have been made on a series of alloys containing up to 1 per cent. of arsenic and the paper describes the effects of arsenic on the casting and working properties of these materials. Tests have also been made on the mechanical properties—etnsile tests at ordinary temperatures and at 250° C. hardness tests, fatigue range and notched-bar impact test; while the effects of arsenic on the electric conductivity, both at 20°C and 65°C., have also been examined. The effects of arsenic on the macrostructure and microstructure of copper have also been determined, and the solubility of arsenic in solid copper has been investigated.

In Part IV. a similar series of tests has been carried out on copper containing up to 2 per cent. of arsenic and 0.1 per cent. of oxygen, with a view to ascertaining the influence of each of these elements on the presence of the other. In particular, the influence of arsenic in modifying the cold-shortness of copper containing oxygen has been investigated.

Experiments on the gassing of copper by hydrogen have also been undertaken with a view to ascertaining the influence, if any, of arsenic on the gassing of oxygen-bearing copper.

Brittleness in Arsenical Copper. By Clement Blazey, M.Sc., Member.

A description is given of a type of brittleness in arsenical copper tubing developed by annealing in the temperature range 450° to about 650° C. The susceptibility to brittleness was inherent in the "as-cast" billets from which the tubes were made, and no alterationin hot and cold working methods could eliminate it. The degree of susceptibility varied from billet to billet, but the variation could not be connected with chemical composition. After remelting, no trace of brittleness could be developed. Over a period of several years the brittleness was encountered in a certain mill on three occasions, and appeared to be connected with the composition of the refinery charges and with melting operations.

Electric Furnaces in Non-Ferrous Metallurgy. By D. F. Campbell, M.A., A.R.S.M. Member.

This paper deals in a practical way with the principal electric furnaces now used for melting alloys of copper, nickel, zinc, and silver, with special reference to induction furnaces of normal and high-frequency.

The Penetration of Mild Steel by Brazing Solder and Other Metals. By R. Genders, M.B.E., M.Met., F.I.C., Member.

The cracking of mild steel under slight stress when heated and wetted with brazing solder is due to rapid intercrystallisation penetration of the steel by the brass. Copper behaves similarly to brass, but zinc, tin, and lead-tin solder have no perceptible action. The behaviour of mild steel in comparison with that of other metals when stressed and exposed to corrosive media is considered. It is suggested that the phenomenon of intercrystalline penetration is in many cases of a complex character, involving a third factor.

The Penetration of Brass by Tin and Solder. With a Few Notes on the Copper-Tin Equilibrium Diagram. By H. J. Miller, M.Sc., Student Member.

The cracking of stressed brass articles by a process of intercrystalline penetration when in contact with molten solder of the tin-lead variety is associated with the phenomenon of "season-cracking" and the penetration of mercury into brass. Tensile tests upon brass test-pieces which are surrounded by various molten metals and solders indicate that that required for the penetration of mercury; experiments with stressed brass tubes also indicate that high stresses are required for penetration to take place.

Some subsidiary experiments with copper-tin alloys indicate that the eutectic composition of the series occurs with about 0.7 per cent. of copper as against 1 per cent. by

Heycock and Neville, 2 per cent. by Guertler, Shepherd and Blough, and 5 per cent. by Giolitti and Tavanti.

The Attack of Molten Metals on Certain Non-Ferrous Metals and Alloys. By HAROLD J. HARTLEY, M.Sc., Student Member.

The attack of molten tin and tin containing solders upon brass and copper have been studied, taking the time factor into consideration. Penetration of the molten into the solid material occure when the latter is stressed in tension. Fully annealed materials are attacked at very low stresses with ultimate breakdown.

Notes on the Manufacture and Properties of Hairsprings. By H. MOORE, O.B.E., D.Sc., Member, AND S. BECKINSALE, B.Sc., A.I.C., Member.

The function and essential properties of hairsprings and control springs are discussed. The respective merits and disadvantages of steels, ferrous alloys (*e.g.*, Elinvan), and non-ferrous metals and alloys as hairspring materials are indicated. To raise the elastic limit to the required degree, hardening by heat-treatment or by cold-working is necessary, but all hardening operations are liable to produce a state of imperfect elasticity detrimental to the spring. The use of low-temperature heat-treatments to restore elasticity after cold-working (drawing ,rolling, and the coiling of the spring) is described. Steel hairsprings are subject to corrosion, but Elinvar is highly resistant. Some details of the manufacture of phosphor-bronze and other hairsprings are given, and the selection of material for hairsprings required to have a low electrical resistance is discussed.

The Application of Strain Methods to the Investigation of the Structure of Eutectic Alloys. By F. HARGREAVES, A.R.S.M., D.I.C., F.I.C., Member.

Investigations of the lead-tin, tin-zinc, and copper-silver eutectics shows that straining by suitable methods results in markings due to slip, similar to those which occur in the case of pure metals. The orientation of the lead-tin eutectic is apparently determined by that of the tin.

Note on the Crystallisation of the Lead-Tin Eutectic. By F. HARGREAVES, A.R.S.M., D.I.C., F.I.C., Member.

Straining and etching methods applied to a 30-lb ingot of lead-tin eutectic show the exterior to possess the largest crystal size with absence of distinct colonies. The middle consists of much smaller crystal units in the form of distinct colonies of coarser eutectic structure.

The Influence of Calcium on Aluminium containing Silicon. By J. D. GROGAN, B.A., Member. With an Appendix on "The Estimation of Calcium in Aluminium Alloys." By P. G. WARD, B.Sc., A.R.C.S.

Calcium combines with the silicon present in commercial aluminium, forming a compound probably $CaSi_2$. This compound is almost insoluble in solid aluminium at all temperatures and exerts no age-hardening influence. By removing silicon from solid solution in aluminium calcium improves the electrical conductivity of the latter.

Note on the Magnesium-Rich Magnesium-Copper Alloys. By M. HANSEN, Dr.Phil., Member.

The paper contains the results of investigation of the solubility of copper in solid magnesium and the mechanical properties of some magnesium-rich magnesium-copper alloys. Some indication of the phase boundary of the solid solution of magnesium with copper has been obtained. The microstructure of quenched and slowly cooled alloys is illustrated by means of photographs. The quenched alloys show no perceptible hardening by ageing. Some mechanical properties of extruded material both with and without heat-treatment are given.

The Mechanism of Inverse Segregation in Alloys. By R. GENDERS, M.B.E., M.Met., F.I.C., Member. With an Appendix on the "Accurate Determination of Copper in Bronze by Electrolysis." By R. A. F. HAMMOND, B.Sc., A.R.C.Sc., A.I.C.

The hypotheses put forward to account for the occurrence of inverse segregation in alloys are critically discussed. None is fully in accordance with experimental fact, and it is evident that some factor is involved in the phenomenon, the influence of which has not yet been taken into consideration. Preliminary experiments are described showing that, in extreme cases of inverse segregation, exudation at the surface of the casting occurs simultaneously with the escape of evolved gases. The variation of composition in chill-cast slabs of bronze containing 5 per cent. tin made by various methods of casting were determined. The previous work of the author on the flow taking place in the mould during the formation of the ingot is considered in relation to these results. A general theory of in-

verse segregation is advanced, in which the gas constituent in alloys is considered as part of the system. The evolution of gas from solution in the metal is regarded as of primary importance in determining variations in composition in the solid casting. Representative experimental data are explained by means of the theory, and methods of avoiding inverse segregation are discussed.

Magnetic Analysis as a Means of Studying the Structure of Non-Magnetic Alloys. By PROF. K. HONDA, Sc.D, Member, AND PROF. H. ENDO, M.Sc., Member.

The present investigation is to show by means of examples that magnetic analysis applied to the case of non-magnetic elements, which are paramagnetic or diamagnetic, affords a very convenient method of studying the equilibrium diagram for the alloys consisting of these elements. Not only is the melting point or the transformation point of an element given by a sharp discontinuity of the susceptibility-temperature curve, but the liquidus and the solidus of an alloy are also marked by a sharp break or bend in the same curve. In some cases, small solubility is marked by a very large abrupt diminution of the diamagnetic susceptibility of one component on adding a small quantity of the other. The magnetic analysis is also a very convenient method for the study of the actual state of an alloy when above its melting point, that is, in detecting the existence of an intermetallic compound in the liquid phase, the degree of dissociation of the compound with the rise of temperature, etc.

An Etching Reagent for Copper. By PROF. B. W. HOLMAN, O.B.E.. A.R.S.M., Member.

The note describes the use of silver nitrate as an etching agent for copper, and suggests its utility in research work. The intricate etching figures sometimes produced by this method are commented on.

Examination of a Fifteenth-Century 'Brass,' " By J. NEWTON FRIEND, D.Sc., Ph.D., F.I.C., Member, AND W. E. THORNEYCROFT, B.Sc., Member.

A brief account of the tomb of Richard Beuchamp at Warwick, and an analysis and micrographs of portions of the bronze statue are given.

Note on the Silver Contents of Roman Lead from Folkestone and Richboro' Castle. By J. NEWTON FRIEND, D.Sc., Ph.D., F.I.C., Member, AND W. E. THORNECROFT, B.Sc., Member.

Specimens of Roman lead from Folkestone and Richboro' Castle have been analysed. The former contained 0.0072 and the latter 0.0078 per cent. of silver.

THE ROYAL INSTITUTION.

Rigidity and Other Anomalies in Colloidal Solutions. By EMIL HATSCHEK.

The term rigidity is defined and its quantitative expression, the modulus of rigidity deduced. The behaviour of a rigid body subject to shear is illustrated by means of a cube of gelatin jelly, which also exhibits the phenomenon of accidental double refraction. The behaviour of a normal liquid is contrasted with that of the elastic solid by the discussion of an ideal case, *viz.*, a liquid contained between two parallel plates, one of which moves with uniform velocity. A quantitative expression, the coefficient of viscosity, is deduced from the terms of the ideal experiment. This coefficient decreases with temperature, but in normal liquids is independent of the velocity gradient.

The study of the viscosity of colloidal solutions by means of the capillary instrument was begun by Thomas Graham. Investigations by subsequent observers using the same method revealed anomalies, which became more defined in an investigation by a different method, used by Garrett (1903). Definitive attempts to elucidate the problem were first made by Prof. W. R. Hoss and by E. Hatchek independently. These established the fact that the viscosity of colloidal solutions, unlike that of normal liquids, is not independent of the velocity gradient, but varies with it. The variation is the same in all solutions so far studied; the viscosity decreases with increasing gradient and approaches or reaches a constant value, while with decreasing gradient it grows asymptotically. A number of viscosity-gradient curves obtained by Hatschek, and by Freundlich and collaborators, are shown, and the working of the concentric cylinder apparatus, in which they are obtained. is demonstrated.

A possible and widely accepted explanation of the anomalous viscosity is that these solutions possess rigidity. It can be demonstrated mathematically that a liquid possessing rigidity would have a variable viscosity. Rigidity in many of the colloidal solutions can be demonstrated, and the modulus can be measured, by very delicate apparatus;

it can however, be easily observed in dilute ammonium oleate solutions. If a cylinder is suspended in this liquid and given a rotary movement, it comes to rest, as it would in normal liquids, but then rotates backwards. The ammonium oleate is further highly anomalous as regards viscosity; this behaviour is demonstrated in the cylinder apparatus, in which no definite reading can be obtained with it.

The method of measuring the modulus of rigidity of liquids is described and a number of values obtained by it are given; they are of the order of milligrammes per sq. cm. In most cases the modulus increases with age; in all solutions examined rigidity disappears on warming to about 40°, but returns in varying degrees on cooling.

Since rigid solutions, unlike normal liquids, can be deformed, they show double refraction when sheared; this is demonstrated with cotton yellow and mercury-sulphosalicylic acid. Double refraction disappears with rigidity; in the mercury sulphosalicylic aid it does so not only on heating but on addition of sodium chloride.

Suggestions put forward to account for these anomalies amount in general to assumptions of special structures in these liquids, of an order of magnitude larger than molecular but modelled on the shape of the molecule. Such explanations are held to be inadequate on account of the extreme chemical diversity of the substances which exhibit anomaly. Furthermore, variable viscosity has been shown to be a property also of coarse suspensions of nearly spherical particles in indifferent normal liquids, which do not arrange themselves into any ordered structures.

The bearing of the phenomena described, especially of the asymptotic increase of viscosity with decreasing rate of deformation, on a number of problems is discussed. It is specially pointed out that the peculiar properties of both the liquid and solid state, the one or the other preponderating according to the rate of information.

SOCIETY OF PUBLIC ANALYSTS.

The Annual General Meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, March 2, when the President, Mr. E. Richards Bolton, delivered his annual address.

The following were elected as Officers and Council for the year 1927 :—

President—E .Richards Bolton.

Past Presidents, serving on the Council—Leonard Archbutt, A. Chaston Chapman, Bernard Dyer, P. A. Ellis Richards, Alfred Smetham, G. Rudd Thompson, E. W. Voelcker, J. Augustus Voelker.

Vice-Presidents—R. L. Collett, C. H. Cribb, John White.

Hon.Treasurer—Edward Hinks.

Hon. Secretary—F. W. F. Arnaud.

Members of Council—L. K. Boseley, H. E. Cox, John Evans, J. Golding, J. T. Hewitt, H. T. Lea, E. K. Rideal, W. H. Roberts, E. H. Merritt, W. H. Simmons, M. S. Salamon, James Wood.

An Ordinary Meeting of the Society then followed, the President, Mr. E. R. Bolton, being in the chair.

Certificates were read for the first time in favour of Alfred George James Lipscombe, B.Sc. (London.), A.I.C.; William L. Matthews, Sydney John Rogers, B.Sc., F.I.C.; Ernest Fred Waterhouse; Harold William Webb; Arthur Samuel Wood, M.Sc., Ph.D., A.M.I.Chem.E., F.I.C.

Certificates were read for the second time in favour of William Gordon Carey, F.I.C.; William Farrand Elvidge, B.Sc., A.I.C.; Lewis Sidney Fraser, B.Sc., A.R.C.Sc., A.I.C.; Frederick Percival Hornby, B.Sc., A.I.C.; Gerald Roche Lynch, O.B.E., M.B., B.S., D.P.H.; Eric C. Martin; George Gilmour Philip.

The following were elected Members of the Society : Solomon Greenberg, F.I.C.; Frank Crafer Ray, M.A., F.I.C.; and Geoffrey Charles Matthews, B.Sc., A.I.C.

The President, Mr. E. Richards Bolton, F.I.C., in his address, gave a blessing to the new Preservatives Regulations, which, he said, placed both the public analyst and the manufacturer in a much happier position than they were in before, because they prevented an unreasonable analyst from extremes of unreasonableness, and confined each and every manufacturer within limits beyond which his competitors could not reap an unfair advantage without risk of punishment.

He complimented the free press, which by its habit of continually depreciating our actions ,spurs us on to better things, but he warned us not to be led astray by alarming articles magnifying a few cases of adulteration, thus causing the public to think that we live in the year 1820 when Accum wrote "Death in the Pot."

He gave figures to show how the adulteration of food was steadily decreasing, which he attributed partly to the activity of the authorities, and partly to the efficiency of the public analyst. He urged the manufacturers to avail themselves of the services of a chemist to maintain the purity of their products and advise them in order to enable them to avoid any contravention of the law. Finally, he gave it as his opinion that the food of the country was never in a purer state than it is at the present time.

The following papers were read and discussed :—

Cacao Butter Substitutes and their Detection. By A. W. Knapp, B.Sc., F.I.C., J. E. Moss, M.Sc., A.I.C., and A. Melley.

The most useful single test is the determination of the " titre " of the fatty acids, and, in the absence of certain other fats (*e.g.* coconut oil), this test enables the amount of Borneo tallow in admixture with cacao butter to be approximately determined after reference to a curve. A new method of determination has been based on the fact that the green colour of Borneo tallow is not bleached by ultra-violet light, whereas the yellow colour of cacao butter is readily bleached. A weighed quantity of the fat is exposed for 6 hours to the rays of a standardised quartz mercury vapour lamp, and the colour then compared with the colours of a set of standards containing definite amounts of Borneo tallow.

The Determination of Illipé Butter in Chocolate. By H. W. Bywaters, D.Sc., F.I.C., F. T. Maggs, M.Sc., A.I.C., and C. J. Pool.

A method is based on the fact that melted illipé butter becomes turbid at a much higher temperature than cacao butter, and that the turbidity temperature determined under definite conditions is practically constant for different specimens of the two fats. The method enables the amount of illipé butter in a mixture of the two fats separated from chocolate to be determined with a fair degree of accuracy. If a third fat (e.g., milk fat) is also present, the percentage of illipé butter may still be found by reference to a curve, provided that the amount of the third fat can be ascertained.

A Study of the Determination of Saccharin, Colorimetrically and by the Ammonia Process . By A. F. Lerrigo, B.Sc., F.I.C., and A. L. Williams, A.I.C. (Work done under the Analytical Investigation Scheme.)

The authors have studied five colour reactions of saccharin under variable conditions and have found that none of them gives quantitative results. On the other hand, the ammonia process (in which saccharin is converted into the ammonium salt of sulphobenzoic acid, the ammonia in which is determined by distillation) has been adapted to the determination of small quantities of saccharin.

NOTICES OF BOOKS.

RECENT WORK IN PLANT PHYSIOLOGY.

The latest publication from the Plant Physiology Laboratory of the Charles University, Prague, contains several important contributions. Dr. L. Reich deals exhaustively from both theoretical and practical standpoints with the physiological action of radioactive rays. It is found that these rays influence the respiration of the cells. Breathing and growth are also affected and stimulated. The author appends a very lengthy bibliography on this work.

There is an article by Dr. L. Mullerova on the fermentation of certain carbohydrates by organisms of the Friedländer group.

The culture of calcareous *Cyanophyceæ* is discussed by Dr. S. Prat. Prof. B. Nemec contributes three articles, one on the dorsiventrality of some of the fungi fructifications and another on the regeneration phenomenon in *Lenzites sepiaria.* The third deals with observations on the regeneration of *Collybia tuberosa.*

The volume also includes an article on the influence of cations on the starch in roots by Dr. J. Roubal.

An Introduction to the Chemical Technology of Fuels. (*Einführung in die Chemische Technologie der Brennstoffe.*) Von Dr. E. Graefe. Pp. viii + 197, and 91 illustrations. Dresden and Leipzig : Theodor Steinkopff. 1927. Price, Paper, 10 m.; bound, 11m. 50pf.

This book is designed to meet the needs of German students in technical and technological colleges, as far as fuel technology is concerned. It is German in its thoroughness, covering all fuels and all methods of fuel consumption that are in use to-day.

Dr. Graefe, who is responsible for three articles in the book, is the editor, and he has endeavoured to avoid all unnecessary overlapping, which is to some extent inevitable and excusable, when seven experts write about various aspects of the same subject.

The Theory of Combustion is dealt with in the first article, by Dr. Heinrich Menzel, who divides all combustion processes into two groups, (1) complete combustion, in which all the possible heat is obtained from the fuel used, and (2) partial combustion, in which the object of the combustion process is to form combustible substances, as, for example, the destructive distillation of coal to form coke and by-products.

Improvements in Coal Technology is the subject of the section written by Dipl. Ing. F. Schreiber. This covers coal-mining, screening, washing, and all other treatment of coal at the pithead, as well as briquetting and coke oven practice.

Gas for Lighting and *Industrial Gas* are two articles contributed by Dr. Schroth, the director of the municipal gasworks at Dresden. Dr. Schroth has enumerated the modern processes of gas making and enrichment, and he illustrates the gradual change from retorts ,horizontal ,inclined and vertical, to chambers, both inclined and vertical, which is slowly taking place to-day.

Brown Coal, The Brown Coal Tar Industry and *The Shale Oil Industry* are three articles by the Editor, Dr. Edmund Graefe, who in the first describes the winning and general uses of brown coal (Lignite), which from a table he gives appears to be any kind of coal between " stone-coal " (as the Germans call it), and peat.

Peat. The mechanical winning of peat, its treatment, its use as a gas producer, and its distillation to form peat-tar and peat-coke, are dealt with briefly by Professor Keppeler. This article should be of interest to engineers and technical students in Ireland. During the war, and, more recently, during the coal dispute the value of peat was fully realised in Ireland as well as in Germany, and the more systematic extraction of peat in Ireland may be expected to follow closely on any improvements in the mechanical excavation, maceration, drying, and handling of that little used fuel. Incidentally it may be stated that during the recent dispute, a firm in Ireland discovered that two tons of peat at £1 per ton were equivalent to one ton of continental coal at £4 per ton.

Petroleum. This section, by Dr. Kissling, deals briefly with the geological formation of petroleum, its occurrence, and extraction, and at greater length, with the chief methods of distillation. One interesting fact is pointed out by Dr. Kissling, that the various distillation processes used do not depend so much on the nature of the crude petroleum, so much as the distillation products required, which, in turn, depend upon the world demand at the time of distillation.

The last section dealing with *Methods of Testing Solid and Fluid Fuels*, contributed by Dr. Aufhäuser, describes the experiments conducted in the laboratory whereby the value of a fuel is determined. He describes the quantitative analysis of a sample of coal to determine the carbon, ash, water, and volatile content thereof, and the method of ascertaining the heat value of coal (or any other fuel), by means of the bomb calorimeter.

In his introduction Dr. Graefe says that the book is designed to cover the present day practice in fuel consumption. It can safely be said that this is done, and done thoroughly, as the articles are crammed with information, showing that each writer has condensed into one article what he would like to have described at much greater length had he been allowed.

This useful book should be in the hands of all students of the subject.

J. H. A.

CATALYTIC CONDENSATION PRODUCT.

(*To the Editor of the* CHEMICAL NEWS.)

In my letter to you on " A Catalytic Condensation Product from Acetylene," which appeared in your issue of February 18, 1927, p. 110, a seemingly small, but nevertheless embarrassing, error in typography appeared. The fifth line of my letter as printed includes the phrase " reference to *my* notes," whereas I really wrote " reference to *the* notes."

This particular work was done under the direction of Mr. G. W, Acheson, who is continuing the work of his illustrious father, Dr. Edward Goodrich Acheson, and reference to this error is made in justice to him.

Very truly yours,

RAYMOND SZYMANOWITZ.

41, Compton Terrace,
Hillside, N.J., U.S.A.

U.S.A. OFFICIAL PUBLICATIONS.

Department of the Interior.

"Topographical Instructions of the U.S.A. Geological Survey." (Administration.)

"The Fauna of the Ripley Formation on Coon Creek, Tennessee." (Large number of plates and other illustrations.)

"American Tertiary Mollusks of the Genus Clementia."

Surface Water Supply of the U.S.A. in 1921. Part X. The Grant Basin. Part IV. St. Lawrence River Basin."

"Surface Water Supply of Hawaii—July 1, 1921, to June 30, 1922."

"North Pacific Slope Drainage Basins. Part XII."

Bureau of Mines.

"Talc and Soapstone in 1924."

"Nine Rare Metals in 1924."

"Gold, Silver ,Copper, Lead and Zinc in Montana in 1924."

"Diamond Drilling."

"Accidents due to Explosives in Metal Mines of the South-West."

"Strength of Ore and Top Rock in the Red Iron Ore Mines of the Birmingham District, Ala."

"Gold, Silver and Copper in South Dakota and Wyoming in 1925."

"Iron Ore, Pig Iron and Steel in 1925."

"Phosphate Rock in 1925."

Department of Commerce.

"Elimination of Waste—Hollow Building Tile."

"Asphalt — A Primer of Simplified Practice."

"Cooking of Oil Shales."

"Mercury in 1925."

"Alkali Cyanides in the Iron Blast Furnaces."

"Resistance of Conductors of Various Types (150 to 6,000 Kilocycles)."

"U.S.A. Government Master Specification for Making Rubber for use around Electrical Circuits not exceeding 3,000 Volts to Ground."

"Specification for Caustic Soda (Lye)."

"Specification for Soap, Cake, Grit."

"Tests of Large Columns with H-shaped Sections."

"Production of Explosives in the U.S.A. in 1925."

"Lead in 1925" (Smelter Report).

"Coke Oven Accidents in the U.S.A., during 1925."

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

The following papers will be read on Thursday, March 31, at 4.30 p.m. :—

"Alloys of Iron and Manganese of Low Carbon Content." By Sir Robert Hadfield, F.R.S.

"The Thermal and Electrical Conductivity of a Single Crystal of Aluminium." By E. Griffiths, F.R.S.

"The Transverse Magneto-Resistance Effect in Single Crystals of Iron." By W. L. Webster.

The following papers will be read in title only :—

"*The Initial Stages of Gaseous Explosions.* Part III. The Behaviour of an Equimolecular Methane-Oxygen Mixture when Fired with Sparks of Varying Intensities." By W. A. Bone, F.R.S., R. P. Fraser, and F. Witt.

"The Expansion of Charcoal on Sorption of Carbon Dioxide." By F. T. Meehan.

"The Equation of State of a Gaseous Mixture." J. F. Lennard-Jones and W. R. Cook.

ROYAL SOCIETY OF ARTS.

Monday, March 28, at 8 p.m.—(Cantor Lecture.) G. I. Finch, Imperial College of Science and Technology : "Some Industrial Applications of Electrothermics." (Lecture III.)

Tuesday, March 29, at 4.30 p.m.—(Dominion and Colonial Meeting.) J. H. Oldham, Secretary of the International Missionary Council and Member of the Colonial Office Advisory Committee on Native Education in Tropical Africa : "Tendencies in African Native Education."

INSTITUTION OF ELECTRICAL ENGINEERS.

Thursday, March 31, at 6 p.m.—Ordinary meeting in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C.2. "The Applications of Electricity in Warships." By W. McClelland, C.B., O.B.E. (Member).

North-Eastern Centre.—"The Number of Tests required to Establish the Rupturing Capacity of an Oil Circuit-Breaker." (To be illustrated by a cinematograph film.) (At the Literary and Philosophical Society, Westgate Road, Newcastle-on-Tyne, at 7 p.m.)

THE PHYSICAL SOCIETY.

Imperial College of Science, S. Kensington.

The following papers will be read at the meeting on Friday, March 25, at 5 p.m. :—

E. Mollett, D.Sc. : "Acoustic Experiments with a Mechanical Vibrator."

E. T. Paris, D.Sc., F.Inst.P. : "The Stationary Wave Method of Measuring Sound Absorption at Normal Incidence."

J. H. Awbery, B.A., B.Sc., and Ezer Griffiths, D.Sc., F.R.S. : "A Ball and Tube Flowmeter suitable for Pressure Circuits."

Allan Ferguson, M.A., D.Sc. : "A Demonstration of the Astrolabe and some other Mediaeval Surveying and Navigational Instruments."

THE ROYAL INSTITUTION.

21, Albemarle Street, W.1.

Saturday, March 26, at 3 p.m.—"The Alpha Rays and Atomic Structure." By Sir Ernest Rutherford.

Tuesday, March 29, at 5.15 p.m.—"Some Properties of Coke." By Prof. J. W. Cobb.

Thursday, March 31, at 5.15 p.m.—"The Beginnings and Early Spread of Agriculture." By Mr. Harold Peake.

Friday, April 1, at 9 p.m.—"The Stones of London." By Mr. J. Allen Howe.

Saturday, April 2, at 3 p.m.—"The Alpha Rays and Atomic Structure." By Sir Ernest Rutherford.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

5,571.—Bachmann, W.—Production of active silica acid. February 28th.

6,160.—Chemical Works formerly Sandoz.—Preparation of soluble derivatives of meta-aminobenzoic acid esters. March 4th.

5,967, 5,968.—I. G. Farbenindustrie Akt.-Ges.—Apparatus for carrying out chemical, etc. processes. March 3rd.

5,747.—Nishinawa, T.—Manufacture of ammonium sulphate. March 1st.

5,552.—Pease, E. L.—Manufacture of potassium phosphate, etc. February 28th.

Specifications Published.

266,209.—Chemisch-Pharmazeutische Akt.-Bad Homburg.—Process for the manufacture of quinine solutions suitable for subcutaneous injections.

266,397.—Skoglund, J. V.—Method of manufacturing sulphuric acid.

266,404.—Cassella & Co. Ges. Ransford, A. J., and Carpmael, O.—Vat dyestuffs.

266,405.—Badische Anilin and Soda Fabrik.—Manufacture and production of organic compounds containing oxygen.

266,607.—Badische Anilin & Soda Fabrik.—Manufacture and production of organic compounds containing oxygen.

266,607.—Colman, Dr. J.—Process for the production of double salts of calcium halides with calcium lactate.

263,843.—Dyes.—I. G. Farbenindustrie-Akt.-Ges., Frankfort - on - Main, Germany.

Abstract Published.

Anthraquinonethiomorpholines are obtained by condensing *o*-aminoanthraquinonemercaptans with alkylenehalides; the *o*-aminoanthraquinone - halogenalkylthioethers first formed readily lose halogen halide, in some cases on drying, and form the thiomorpholines. According to examples (1) sodium-1-aminoanthraquinone-2-mercaptan is condensed with ethylenebromide; the 1-amino-2-anthraquinone-ω-bromethylthioether obtained is converted into the thiomorpholine by drying at 100° C., or better by heating in trichlorbenzene with copper powder : (2) 1-amino-4-brom-2-anthraquinone-ω-bromethylthioether (obtained by brominating 1-amino-2-anthraquinone-ω-bromethylthioether) is heated in aniline to effect ring closure; sodium acetate and copper are then added and heating continued until the mass has become blue;

the product on sulphonation dyes wool in greyish-blue shades. As parent material are also specified 1 : 5-diaminoanthraquinone-2 : 6-dimercaptan, 1 : 8-diaminoanthraquinone - 2 : 7 - dimercaptan, 1 -amino - 4-toluido-2-anthraquinonemercaptan and 2-anthraquinone-3-mercaptan (obtainable from 2-amino-3-bromanthraquinone). The ethylene bromide may be replaced by bromchlorethylene, dichlorethylene, or $\alpha:\beta$-dichlorhydrin.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

SYNTHITE.

475,777.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Synthite, Limited, Wood Street Works, Wood Street, Ryders Green, West Bromwich, Staffordshire. March 9th.

KENTOX.

476,958.—Weed killer (chemical).—Abol, Limited, Beltring, Paddock Wood, Kent. March 9th.

SLUGICIDE.

476,595.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—The British Drug Houses, Limited, 16 to 30, Graham Street, City Road, London ,N.1. March 9th.

CYCLAX.

477,234.—All goods in Class 2 which includes chemical substances used for agricultural, horticultural, veterinary, and sanitary purposes.—Fanny Lester, trading as Mrs. Hemming, and as "Cyclax" Company, 58, South Moulton Street, London, W.1. March 9th.

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THE CHEMICAL NEWS

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A SELECTIVE DISPLACEMENT OF 0.0153A in X-RAY SPECTRAL LINES. PART IV.

By F. H. LORING.

In Part II. (*Chem. News*, 1927, cxxxiv., 97), the Cu$K\beta_1$ line was given as 1.38887. This value was taken from H. Mark's "Die Verwendung der Röntgenstrahlen in Chemie und Technik," 1926, p. 132. The writer was under the impression that Mark's tables agreed throughout with the values in Lindsay's translation (1925) of Siegbahn's book. It is interesting to note that in the latter book the value is given as 1.38933, while the new value by Leide (as previously cited) is 1.38929, making a difference of only 0.00004A; but, on the other hand Wennerlöf's (*Zeit. für Physik*, 1927, XLI, 524) new determinations of some of the L-series lines for tantalum show a difference of the order 0.0008A when compared with the corresponding values given in either of the above books.

The argument previously given implying that the wave-lengths were not yet brought to a 4th-demical-place accuracy still holds good in many cases in the region under consideration. It is not necessary here to cite all the original investigators on this work, it being sufficient to refer either to Siegbahn's or Mark's book, and the recent work, as the values used in this study are not all precision determinations, though the work of J. S. Rogers and Rogers, Lapp and Hopkins is no doubt of a high order and may be so classed.

The opportunity is here taken to append a revised table which is explanatory when compared with the previous tables. There can be no finality in revised tables for the whole matter is not free from some chance coincidences; but as this has been discussed before there is no need to labour the point here. The real cause of the supposed displacements cannot be given, and using 2Δ and 4Δ values increases the chance of such coincidences; but, it will be seen that the appearance of the ruthenium lines in place of the molybdenum lines (see *Chem. News*, 1926, CXXXIII., 356), can be explained on the theory of such real displacements, whatever they may mean. The ytterbium line synthesis, so to speak, is not explained in this way, and a close comparison line was available in this case. The Mo$K\alpha_2$ line should be taken into account below, but this makes the difference greater.

TABLE (*Revised.*)

x-line	x+1Δ	x+2Δ	x+4Δ	Identification			Difference
1.4503	1.46555			Ta$L\eta$	=	1.4655 S	+ 0.00005
1.3735	1.38875			Os$L\alpha_1$	=	1.38816S	+ 0.00059
1.3212	1.33645			Ga$K\alpha_1$	=	1.3367 G	- 0.00025
1.2487		1.2792		W$L\beta_1$	=	1.27917S	+ 0.00003
1.2300		1.2605		W$L\beta_3$	=	1.26000S	+ 0.00050
1.1138	1.12905			W$L\gamma_5$	=	1.1292 S	- 0.00015
1.0862		1.1167		Pt$L\beta_1$	=	1.11722S	- 0.00052

1.6927	1.70795			Dy$L\beta_1$	=	1.70658S	+ 0.00137
1.5878		1.6183		Dy$L\beta_2$	=	1.6198 S	- 0.00150
1.5486	1.56385			Ho$L\beta_2$	=	1.5637 S	+ 0.00015
1.4051	1.42035			Dy$L\gamma_2$	=	1.4203 S	+ 0.00005
1.3753			1.4363	Zn$K\alpha_2$	=	1.43587L	+ 0.00043
1.3604			1.4214	Lu$L\beta_1$	=	1.4207 S	+ 0.00070
1.3441	1.35935			Ir$L\alpha_2$	=	1.35939S	- 0.00004
1.2487		1.2792		W$L\beta_1$	=	1.27917S	+ 0.00003
1.233*	....	....	....	Hg$L\alpha_1$	=	1.2385 S	- 0.00550†
1.0305*	1.04575			Hg$L\beta_1$	=	1.0458 S	- 0.00005
1.434	....	....	....	ZnK$\alpha_2\alpha_1$	=	1.43396L	+ 0.00004
0.6439*			0.7049	Mo$K\alpha_1$	=	0.70780L	- 0.00290†
0.5724*			0.6334	Mo$K\beta_1$	=	0.63124L	+ 0.00216†

S = From Siegbahn's book, 1925, English trans.
G = From Gunther's "Tabellen," 1924.
L = From Leide's new determinations (1926).
* = Mean value.
† = The order of error in this case.

NOTES.—Wennerlöf (1927, *loc. cit.*) has not given a new determination for the Ta$L\eta$ line. Perhaps this line should be queried as an identification one. Δ = 0.01525A in the above table. Δ seems to lie between 0.01523 and 0.0153. The *plus* and *minus* differences are given to the 5th place of decimals, regardless of the significance of going so far, for the sake of uniformity in settling up the table. The critical remarks made in several places still apply.

A. E. Lindh (*Phys. Zeit.*, 1927, pp. 24 and 93), has given a long paper on X-ray spectra, with full tables; but for more complete information recent work, as cited above, must be followed.

ATMOSPHERIC CORROSION.

DR. W. H. J. VERNON presented to the *Faraday Society* at its meeting on March 1926, the Second Experimental Report on Atmospheric Corrosion. This work has been instigated by the British Non-Ferrous Metals Research Association.

The report is concerned with the behaviour of typical metals and alloys on exposure to the atmosphere; it is divided into two parts, dealing respectively with "indoor" and "open-air" exposure tests, the former including associated laboratory experiments. It is shown that conclusions which hold good for a given set of conditions do not necessarily apply when those conditions are changed; this is exemplified by the influence of "impurities" in copper. Indoors, under conditions such that only tarnishing has to be considered, a given element exercises an effect which is either negligible, or in simple proportion to the amount of element present. Exposed to the open air, however, the same element may exert an effect out of all proportion to its concentration. It would appear that protection against indoor tarnishing should be sought by methods other than modification of composition alone ;promising results have been obtained in connection with the formation of protective surface films.

INDOOR EXPOSURE TESTS AND LABORATORY EXPERIMENTS.

COPPER.

Development and Inhibition of Tarnishing Phenomena.—Influence of Surface Condition. — The intensity of attack, as measured by weight-increment per unit area, increases with the coarseness of the emery employed in abrasion.

Influence of Chemical Cleaning.—Treatment with solutions containing nitric acid is without appreciable influence upon the behaviour of the metal during subsequent exposure. Solutions containing chromic acid, on the other hand, produce a consider-

able degree of immunity from tarnishing; this immunity may be destroyed by treatment with ammonium chloride.

Influence of Purity of Metal upon rate of tarnishing appears to be negligible (although modifications of composition may have pronounced effects upon the corrosion of copper under conditions of complete exposure to the open air).

Influence of Sulphur Content of Atmosphere. The tarnishing of copper is initiated by atmospheric sulphur, in such form as to respond to the alkaline lead acetate test; the minimum concentration necessary for tarnishing, however, is extremely small (equivalent, approximately, to 1 volume of H_2S in 600 million volumes of air). Above this value tarnishing commences and proceeds at a rate proportional to the " reactive " sulphur content of the atmosphere.

When once a tarnish film is formed, increase in thickness follows accurately a parabolic relationship with time, though the atmospheric sulphur content may fluctuate within extremely wide limits; *i.e.*, rate of tarnishing is determined by the conditions prevailing at the time of the first exposure.

Composition of Tarnish Films, and Mechanism of their Formation.—The sulphur (sulphide) content of tarnish films produced on copper in ordinary room air has not exceeded 15 per cent. Films consisting initially of pure sulphide, on exposure to ordinary room air, increase in thickness and continue through the same sequence of interference colours which they would have done if the original treatment had continued, but they do so mainly through absorption of oxygen. It is concluded that tarnish films consist essentially of isomorphous mixtures of oxide and sulphide, and that in the case of an initially-clean surface, under ordinary conditions of exposure, the surface is activated by the impingement of sulphur atoms, which enter into the formation of the first (mainly oxide) lattice; their relative distribution in this primary lattice then determines the rate of diffusion and the whole subsequent course of tarnishing.

There is reason to believe that if the first oxide lattice is completed before sulphur atoms can impinge (in the form and in the concentration in which they commonly occur in the atmosphere) their subsequent entry in any appreciable amount is prevented, and hence tarnishing in inhibited (see below).

Formation of Protective Oxide Films at Temperatures above Normal.—Whilst at the ordinary temperature there are two alternative types of film possible, *i.e.*, the " tarnish film " and the " protective oxide film," according to the relative purity of the atmosphere, at higher temperatures the latter type is developed to the exclusion of the former. A curve has been plotted which connects the rate of film formation with temperature. There appears, however, to be a critical thickness of film necessary for protection to be afforded against subsequent tarnishing. (For one hour's heating this film is produced between 55° and 75° C.) The evidence leads to the suggestion that the minimum thickness of film necessary for protection is such that the unit lattice of the oxide is completed for the whole of the surface.

Protective Effects of Smoke Films.—It has been found that close contact with smoke from cellulose produces a considerable degree of immunity from tarnishing on subsequent exposure.

Zinc.

Relation between Thickness of Film and Period of Exposure.—The linear relationship between weight-increment and time, found in the earlier work, has been confirmed for relatively long periods of exposure; it holds true also in the early stages, with the probable exception, however, of the first day.

Properties of Oxide Films Developed upon Zinc at the Ordinary Temperature.—The linear relationship between weight-increment and time which characterises the oxidation of zinc at the ordinary temperature, leads to the conclusion that the resulting film must have a granular structure, through the interstices of which gaseous diffusion of the atmosphere takes place. Direct evidence of this has not been obtained by examination under the microscope. Moreover, any colour effects should be due to diffraction and not to interference of light; this is confirmed by the regular appearance of a blue tint, without passage through the sequence of colours which is characteristic of interference.

Brass.

Relation between Weight Increment and Time.—In an atmosphere of varying but mainly low relative humidity, both 70/30 and 60/40 brass for a considerable time simulate the behaviour of copper and yield curves which approximate very closely to the parabola. After more extended exposure however, they revert to the straight line which is characteristic of zinc. In a more humid atmosphere the resemblance to the behaviour of copper appears to disappear altogether.

Effect of Atmospheric Exposure upon Microstructure (60/40 Brass).—In an atmosphere of low relative humidity, containing traces of sulphur compounds characteristic of winter-time town air, the attack is at first chiefly directed upon the alpha constituent, which tarnishes in a similar manner to copper. Subsequently (and more rapidly the greater the humidity)the beta constituent is attacked, but the film is no longer " continuous " and takes the form of isolated pits, giving rise to an apparently duplex structure. It is suggested that this phenomenon is connected with the departure from the parabola to the straight line.

Formation of Protective Oxide Films upon Brass.—The film of oxide produced at the ordinary temperature by exposure to a relatively pure atmosphere, while affording considerable protection to copper, has relatively little effect upon the tarnishing of either 70/30 or 60/40 brass. Films produced at higher temperatures, however, exert a greater protective influence.

Protection by means of Lanoline.—In the case of brass exposed to a relatively humid atmosphere, a considerable degree of protection may be obtained by treatment with lanoline, combined with heat-treatment at 100°.

Behaviour of Brass Compared with that of Copper and Zinc, in Several Types of Indoor Atmospheres.—Results from tests extending over approximately 3½ years may be summarised as follows, the materials in each case being arranged in ascending order of the total corrosion which they have undergone.

A. Atmosphere of varying, but mainly low relative humidity. (1) Copper; (2) 70/30 Brass; (3) 60/40 Brass; (4) Zinc.

The brasses tend to approach nearer to zinc with increasing time.

B. Atmosphere of varying, but mainly high humidity. (1) Copper; (2) Zinc; (3) 60/40 Brass; (4) 70/30 Brass.

C. Domestic Kitchen. (1) Copper; (2) Zinc; (3) 60/40 Brass; (4) 70/30 Brass.

The order is nominally the same as in B, but the attack on 70/30 Brass is now very much greater than that on 60/40.

Analysis of corrosion products from specimen exposed in the domestic kitchen show that a certain amount of the attack is due to organic fatty acids; these appear to act preferentially upon zinc and give rise to their zinc salts in the corrosion products.

Aluminium.

The formation of the primary film of oxide in the very early stages of exposure has been followed by careful gravimetric measurements which have led to the recognition of a weight-increment curve of an essentially different type from any of those previously obtained. Closely resembling a parabola at the outset, it quickly "flattens" towards the time axis, indicating an extremely rapid retardation in the rate of attack. The type of curve suggests that adsorption may play an essential part in the mechanism of oxidation in the present instance. In 10 or 14 days the primary film has practically ceased to thicken. Assuming the film to consist of alumina, either anhydrous or hydrated, the weight-increment then corresponds to a thickness of the order of 100° A.U. Subsequent increases in weight are probably due to the formation of cracks or fissures in the primary film.

Lead.

The weight-increment curve is of the same type as that obtained for aluminium. The nearly flat portion of the curve is reached however in about 7 days and the weight-increment is then only a little more than half that which obtains for almuinium. As in the case of aluminium, the film is completely invisible.

It has been found that in the presence of traces of vapours from drying paint freshly-cleaned lead undergoes rapid oxidation and, in a week or so, becomes deep blue in colour. (Of all the metals examined, the effect is peculiar to lead.) If (however, the metal has been exposed for a sufficient length of time to the uncontaminated atmosphere, it is immune from such attack, owing no doubt to the formation of a protective film of oxide.

Iron.

Atmosphere of Relatively Low Humidity.—In an ordinary room atmosphere of low relative humidity such as obtains under conditions of artificial heating, the process of rusting is controlled entirely by suspended solid impurities in the atmosphere. The weight-increment curve is concave about the time axis, *i.e.*, the rate of attack falls off with increasing time. Rusting may be stopped entirely either by filtering the air, or by screening the specimen behind a single thickness of muslin.

During such time as the iron is exposed to an atmosphere screened from solid particles, it develops a protective film, in an analogous manner to other metals (*i.e.*, copper and lead). On subsequent (normal) exposure this film definitely resists attack for a time, but then breaks down at certain points, following which the localised attack proceeds at an accelerating rate.

Atmosphere of Relatively High Humidity (such as may obtain in an ordinary room which is not artificially heated).—In the presence of suspended solid particles as before, and if the relative humidity is sufficiently high, the rate of attack accelerates from the start, owing to the deposition of particles and concomitant precipitation of moisture. (Rusting may still be prevented by screening behind muslin.) If iron, already covered with (dry) rust, is exposed to an atmosphere of the necessary relative humidity (actually not more that 0 per cent.), an extraordinary acceleration in the rate of attack at once takes place. These phenomena have been observed equally upon ingot iron of commercial quality, highly purified iron, and upon steel containing 0.5 per cent. C.

Atmosphere Saturated with Water Vapour.—Under conditions prevailing at the dew-point, rusting of the iron takes place in the absence of suspended solid particles. The rate of attack accelerates from the start, yielding a curve which is concave about the weight-axis.

Open-Air Exposure Tests.

Intensive tests have been carried out upon specimens of copper, 70/30 brass, 60/40 brass and zinc, in various physical conditions. The rain-water has been collected from beneath these specimens and subjected to analysis at intervals. Information has thus been obtained concerning the weight of metal removed, in relation to the period of exposure. For the whole of the time in the case of copper, and for the major part of the time in the case of other materials, a linear relationship was found. The order in which the materials were affected by this type of attack (*i.e.*, "erosion," as defined in the text), was as follows: Zinc, 70/30, 60/40, copper. In the case of the brasses there was excessive preponderance of zinc over copper in the soluble products.

From the weight of metal removed, and the initial and final weight of the specimen, a value was obtained for the "surrosion," represented by the residual products adhering to the specimens. Analyses of these products were carried out in all cases. The order of "surrosion" for the different materials was as follows: 60/40, 70/30, copper, zinc. Finally, by the summing of erosion and surrosion respectively, values were obtained representing the total corrosion of the specimens, in which respect the materials came out in the following *order of corrodibility*: 60/40, 70/30, zinc, copper.

Further tests, representing over four years' exposure, have been conducted upon various grades of copper, together with 70/30 brass, 60/40 brass and zinc. The order of *resistance to corrosion* is given below, the figures indicating the approximate total corrosion, that of H.C. copper being taken as 100.

Copper with 0.45 per cent arsenic	43
Copper with 2.5 per cent. nickel	61
Copper with 0.8 per cent. tin ...	76
Ordinary copper	81
H.C. Copper	100
70/30 Brass	140
Zinc	155
60/40 Brass	227

In connection with the high resistance displayed by arsenical and nickel copper respectively, it was noted that within the first few days of exposure these materials, among the copper specimens, showed the most rapid loss of reflectivity.

ACHIEVEMENT IN THE MANUFACTURE OF SODA ASH.

In a recent issue of the *Journal of the Japanese Society of Chemical Industry*, an article was contributed by Professor Nishikawa of the Kyushu Imperial ash manufacture in that country. On account of the threatening foreign competition and the difficult of getting the adequate supply of good salt, he says, the manufacture of soda ash has not been an encouraging enterprise, and the only producer at present is the Asahi Glass Co. After an enduring time of ten years on the part of chemists and engineers and with an expenditure of five million yen including loss of three million, the company is now able to supply the soda ash by the ammonia soda process with a little margin of profit. It started the works in 1917 with a daily production of 10 tons, which was increased to 20 tons in 1919, 30 tons in 1922, 50 tons in 1925 and is now 60 tons.

In 1921 a ton of soda ash produced required a consumption of 1.9 tons of salt 85 per cent. purity) and 14 kg of ammonia, the figures has now decreased to 1.78 tons and 9 kg respectively. The chief difficulty lies in the high cost and poor quality of the salt. There is no rock salt bed in this country, neither a brine spring, and the only source of the salt is the sea water. The salt of the home production is too expensive to be used in the manufacture and the industrial salt is imported either from Kwangtung Province or Tsingtau. All of the salts from these regions contain much more impurities, especially magnesium salt, than those imported from Egypt or Spain, but these latter are rather expensive. The following table taken from Prof. Nishikawa's article may give some idea of the quality of the salt used. In the first column is given the classification of the salt into several grades according to the content of magnesium salt. In the second and third are given the number of times, in percentage, of supply shipments of salt, magnesium content of which was just in that particular range classified.

	Magnesium salt content calculated as MgO	Salt from Kwangtung Province	Salt from Tsingtau
A.	less than 0.5%	8.6%	4.8
B.	between 0.5 & 0.7%	5.2	38.8
C.	between 0.7 to 1.0%	32.7	37.1
D.	between 1.0 to 1.3%	34.5	19.3
E.	more than 1.3%	19.0	0
		100	

The production of salt of good quality from sea water on an economical scale is a problem which the Japanese chemical engineer is confronted with.

(From the Journal of the Society of Chemical Industry, Japan.)

THE INSTITUTE OF METALS.

TWENTY YEARS' GROWTH.

Founded in 1908 with a membership of less than 200 the Institute of Metals expects to register its 2000th member before celebrating its 20th anniversary next spring. The total is already over 1,800, and new members are being admitted at the rate of one a day. The next election of members is due to take place on April 13. Persons then elected, in exchange for their first subcription, will have the dual privilege of membership for the extended period ending June 30, 1928, and of receiving an extra copy of the Institute's valuable *Journal*. A new booklet descriptive of the aims and objects of the Institute can be obtained from the Secretary, 14, Members' Mansions, Victoria Street, London, S.W.1.

TRADE ALLOYS.

The Institute of Metals receives such numerous enquiries for the names of the manufacturers of the thousands of "trade alloys" that exist, that it has been decided to compile a list of "trade alloys" together with particulars of their composition and uses, as well as the names of manufacturers or agents in Great Britain. Persons interested are invited to forward to the Secretary, 14, Members' Mansions, London, S.W.1., the following particulars :—

(1) Name of Alloy.
(2) Manufacturer or agent supplying.
(3) Composition.
(4) In what form supplied.
(5) Uses.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

An important aspect of the work on fuel research undertaken by the Department of Scientific and Industrial Research is a survey and classification of the coal seams in the various mining districts by means of physical and chemical tests in the laboratory, supplemented where desirable by large scale tests at H.M. Fuel Research Station, at East Greenwich, or elsewhere. The Fuel Research Board of the Department consider that the best way to carry out this work is by means of local committees representing the local colliery owners and managers, the local branch of the Institution of Mining Engineers, the Fuel Research Board, and the Geological Survey of Great Britain as well as outside scientific interests. Each committee is charged with the duty of supervising the work of the physical and chemical survey in a coal mining area; and in this way the survey becomes of practical value from the commencement, since local knowledge and experience are made available, and the seams to be investigated and the general programme of work are decided by those who are able to estimate most correctly the relative importance of the problems to be solved. The seams selected undergo physical and chemical examination by local investigators appointed for the purpose after which a final selection is made of those seams likely to justify experiments on a technical scale in order to test their suitability for particular uses or methods of treatment.

Committees are actively at work in the following areas :—Lancashire and Cheshire, South Yorkshire, Nottinghamshire and Derbyshire, and North Staffordshire. Another committee is dealing with coalfields of Scotland. A further committee has now been appointed to deal with the coalfields of Durham and Northumberland. The Durham and Northumberland Coal Owners' Associations and the North of England Institute of Mining and Mechanical Engineers are co-operating in this work.

SCIENTIFIC AND INDUSTRIAL RESEARCH.

Mr. Henry Thomas Tizard, C.B., A.F.C., F.R.S., has been appointed by His Majesty the King in Council of the Privy Council for Scientific and Industrial Research on the retirement of Sir H. Frank Heath, K.C.B., from that office on 1, June next.

General Notes.

EXPOSITION OF CHEMICAL INDUSTRIES.

Physical and Chemical Survey of the National Coal Resources.

The rapidity with which the plans for the coming Chemical Industries Exposition to be held in the Grand Central Palace, September 26 to October 1, 1927, are maturing, is proven by the manner and responses that the management is receiving from all over the world from the industry. American manufacturers will be given the opportunity of exhibiting and comparing American products with those of foreign manufacture in the chemical field. The foreign manufacturers of chemical products are showing a keen interest and from all accounts there will be a large display of interesting exhibits.

One of the most interesting and important exhibits will be that of the National Safety Council. This will contain charts outlining the work in the Chemical industry. Particular attention will be paid to the work of this council which has made a nation wide investigation into the hazards of Benzol. The results of this research may be had in a comprehensive pamhlet.

RESEARCH AND THE METAL INDUSTRIES.

An exhibition which has been arranged and opened to the public at the Science Museum, South Kensington, affords some indication of the assistance given to British metal industries by the research and auxiliary services of an industrial research organisation.

The exhibit is that of the British Non-Ferrous Metals Research Association which, with the co-operation of the industry through membership of the Association carries on a two-fold service, firstly in the prosecution of research work either of a fundamental and scientific character or of direct practical utility, and secondly in maintaining a highly organised information service which operates for the general benefit of the Association as a whole and to meet the specific needs of individual member firms.

The present exhibit is concerned chiefly with eight of the Association's researches, chosen from among eighteen major investigations at present in progress. Those selected are typical of the character and wide range of the work which is being car-

ried out, and the exhibits have been set out to give some idea of the scope of each piece of work and the progress which has so far been made.

Some indication of the range of work can be gathered from the subjects chosen for exhibition, which are as follows :—

Effect of impurities up to 1 per cent. on the properties of copper; Brass casting. The surface and internal soundness of Ingots; Die casting alloys : Section I. Brass and bronze alloys, Section II. Aluminium alloys; Spectroscopic assay of zinc; Gases in copper castings; The jointing of metals; "Wiped" plumbers' joints; Atmospheric corrosion.

There is also shown one case which gives information in regard to the Association's administrative, library and information services, with some examples of the work normally carried out in these departments.

The exhibition is open to the public daily and literature descriptive of the material on view and of the other work being carried out by the Association may be obtained at the Science Museum or from the Secretary, B.N.F.M.R.A., 71, Temple Row, Birmingham.

PRESS ROLLS FOR PAPER MACHINES FROM CANADIAN GRANITE.

The High Commissioner for Canada in London has received from the Mines Branch of the Dominion Department of Mines at Ottawa the following article prepared by Mr. L. H. Cole :—

Granite quarries have been in operation in Canada for many years producing building stone, monumental stone, and paving blocks, but it is only within recent years that stone from certain of these quarries has been employed for press rolls for paper machines.

Granite for use in press roll bodies should be fine grained, hard, and of uniform, close texture, free from soft spots which might be acted upon by any chemicals which may remain in the paper stock.

Previous to the year 1923 all of the granite bodies for press rolls used in Canadian paper mills were imported, some from Vermont, U.S.A., and others from Aberdeen, Scotland. A study of the available granites in Canada showed that several of the Canadian deposits contained stone of superior grade capable of being quarried in blocks of sufficient size for the purpose required.

During the past six years approximately 200 granite press rolls from "Canadian Pink" granite have been furnished to paper mills.

INFUSORIAL EARTH INDUSTRY IN NOVA SCOTIA.

A new industry has been established about 17 miles north of Truro, in North Colchester County, by the Oxford Tripoli Sales Co., Inc., for the purpose of working a deposit of infusorial earth, a material largely used by the rubber, drug and polishing trades. A feature of the plant is a huge rotary drying machine in which the raw material is gradually carried to the furnace, where it is calcined. The product is being exported to the United States.

NITROGEN IN INDUSTRY.

The National Research Council at Ottawa has just issued its Bulletin No. 12, dealing with Nitrogen in Industry.

Nitrogen and its compounds play a large and increasingly important part in human welfare. Nature has provided in the atmosphere an inexhaustible supply of this element, but as a gas it is so inert that man has been forced to exercise the greatest ingenuity to devise commercial methods for its fixation. His success in accomplishing this task may be judged from the fact that the amount of nitrogen derived from the air is now considerably greater than that from either of the other two important sources—bituminous coal and the great Chilean deposits of sodium nitrate.

The use of nitrogen as a fertiliser completely overshadows in importance all other applications, and a still further increase in its use may be expected as improved methods lower the cost of production. In addition, nitrogen finds important uses in the manufacture of explosives and dyes, in refrigeration and a multitude of minor applications.

LOW TEMPERATURE CARBONISATION FOR CANADIAN COAL.

Low temperature carbonisation of coal on a large commercial scale is proposed for Canada, according to an announcement at at Ottawa. A syndicate, headed by Mr. Morgan J. O'Brien, is applying to Parliament for a Federal Charter for a three million dollar Corporation. Plans are said to be practically complete for the construction of three 1,000-ton per day plants, one to be in Ottawa and two in Western Ontario. These plants would be operated

by subsidiary Companies and steps are being taken for the organisation of other subsidiary companies to operate plants in Montreal and Quebec. The proposal is to carbonise Canadian slack coal by the low-temperature process which has been made commercially successful in England. A smokeless fuel, said to be equal to the anthracite coal now being sold on Canadian markets, would be produced as well as gas and oil by-products. The process is applicable to all bituminous coals and Mr. O'Brien stated that it is the intention to convey Nova Scotia coal to Ontario and Quebec by water during the open season of navigation while Alberta coal will be treated in the west.

CANADIAN MINING NOTES.

OPERATIONS COMMENCE AT FLIN-FLON.

An important day in the history of Manitoba's mining industry is at hand. Very soon the woods in the vicinity of Lake Athapapuskow will echo the sound of the Flin-Flon starting whistle and announce the inauguration of an enterprise on commercial scale to test the methods developed for the treatment of the immense copper-gold-zinc deposits on the Flin-Flon property.

GEOLOGY CLASS TO TOUR CANADA.

American students in geology will travel 8,000 miles through Canada next summer, visiting and studying important geological formations, according to an announcement by Professor Richard M. Field, of Princeton University, who came to Ottawa to make arrangements with officials there. The twenty students, who are to receive the benefit of this special educational tour, will be selected from educational institutions throughout the United States. They will travel in a specially constructed Pullman car, the "Princeton," equipped with laboratories, maps, charts, radio and kitchen unit.

EMPIRE MINING & METALLURGICAL CONGRESS, CANADA, 1927.

The official journal of the Empire Mining and Metallurgical Congress indicates that the total number of delegates expected at the Congress from whom acceptances had been received at the end of January, stands at 634, but that many more hundreds have asked for further information prior to intimating their intentions.

Two Tours Now Planned.

The large number of members of the Congress who have signified their intention of attending has necessitated the extension of the original plans. Accordingly, a separate tour of Eastern Canada, to be known as "Tour B," has been arranged, in addition to the Western "Tour A."

"Tour A" will leave Montreal on the night of Tuesday, August 23, and travel through Ottawa, Toronto, Niagara Falls, Part Colborne, Hamilton, Toronto, Sudbury, North Bay, South Lorrain, Cobalt, Haileybury, Kirkland Lake, Timmins and Cockrane. From there it will turn west, stopping at Minaki, Winnipeg, Estevan, Banff, Calgary, Fernie, Kimberley, Kootenay Landing, Nelson, Tadanac (or Trail), Princeton, Vancouver, Britannia and Victoria.

It will return East on September 16, *via* Vancouver, Jasper Park, Sterco, Cadomin, Edmonton, Wainwright, Saskatoon, Winnipeg, Fort William and Port Arthur, Cochrane, Taschereau, Noranda (Rouyn), Quebec, Thetford Mines, and Sherbrooke, arriving again in Montreal on the morning of September 28, exactly five and a half weeks after the opening of the Congress, having travelled approximately 7,500 miles.

"Tour B" will travel with "Tour A" as far as Cochrane on the outward journey, and will then turn east, visiting Noranda, Arvida, Quebec, Thetford Mines, Sherbrooke, Minto, Moncton, New Glasgow, and Sydney. It will embark there for Port-aux-Basques in Newfoundland, where it will cross the Island to St. John's. With that point as its headquarters, it will inspect the largest iron mines in the British Empire at Wabana, on Bell Island, in Conception Bay.

Leaving St. John's on September 14, the expedition will travel *via* Port-aux-Basques, Sydney, Moncton and Bathurst, cross the St. Lawrence over the Quebec Bridge, and arrive in Montreal on the evening of September 16th. The party will have travelled from Montreal, about 4,500 miles.

PROCEEDINGS AND NOTICES OF SOCIETIES.

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on March 15, Prof. W. W. Watts, President, in the chair:—

A Melilite-Spurrite-Ca_2SiO_4 *Assemblage from Larne (Antrim)*. By C. E. Tilley,

This contact metamorphic assemblage, together with merfinite, perovskite, wollastonite, aegirine, and other minerals occurs at the border of Cretaceous limestone and a Tertiary dolerite near Larne. The rocks give evidence of considerable chemical interchange during metamorphism of which a detailed account will later be presented.

Alkaline Rocks from Nimrud Volcano, Armenia. By DR. G. T. PRIOR.
Nimrud was a centre of eruption of alkali rocks similar to those of the Rift Valley, East Africa. The lava forming the main mass of the rim and the floor of the crater is a soda-pyroxenes and soda-amphiboles aegirine, cossyrite, and riebeckite. More basic lavas overlying the soda-rhyolites resemble the kenytes of East Africa in containing numerous corroded phenocrysts of anorthoclase. Ordinary olivine-basalts with phenocrysts of labradorite also occur.

Rotating Crystal X-ray Photographs. By G. GREENWOOD.

The first part of the paper deals with this method of crystal analysis as used in the German laboratories, where it was studied by the author. Two substances, tetramethylammonium iodide $N(CH_3)_4I$ and tetraethylammonium iodide $N(C_2H_5)_4I$ were investigated. The unit cell of $N(CH_3)_4I$ is a tetragonal unit of dimensions a = 8.05 A; and c = 5.75 A, and the space group is either D_4^{*} or V^3, most probably the latter. Hence the crystal class is not the holohedral one proposed by L. Vegard. The unit cell of $N(C_2H_5)_4I$ has dimensions a = 12.29 A; c = 6.82 A when referred to the axes demanded by the scalenohedral space group V_d to which the substance belongs. A smaller unit can be found, using as " a " axis half the base-diagonal; the cell then has a = 8.86 A and c = 6.82 A. The nitrogen and the iodine atoms in both substances are crystallographically identical, but the methyl and ethyl radicles may be half of one kind and half of another. The hypothetical structures ,suggested for these substances by Groth, as deduced from topic axes, are also discussed.

Biographical Notices of Mineralogists Recently Deceased. By DR. L. J. SPENCER. (Third Series).

The average age of the forty lives described is 68 years.

RECENT DEVELOPMENTS IN THE ART OF FINE MEASUREMENT.

By JOHN E. SEARS, JUN., C.B.E., M.A., M.I.Mech.E.

(Read before the Royal Institution of Great Britain.)

ABSTRACT.

The subject of Metrology may perhaps more strictly be regarded as an art than as a science. At the same time, one cannot overlook the fundamental truth of Lord Kelvin's famous saying, that nothing is really known until one is able to measure it, nor the equally fundamental fact that all measurement, in the last resort, resolves itself into a determination of one or other of the three elementary quantities—mass, length, or time. Metrology thus lies at the root of all quantitative science, and the relationship is reciprocal, for metrology in its turn makes use of every advance in science or in mechanical art which may serve to aid the attainment of greater accuracy in measurement.

In this discourse I am going to confine myself to one branch only of metrology—the measurement of length—in which, in spite of the antiquity of the subject, great advances have been achieved in comparatively modern times, and particularly in the last few decades. I shall commence with a short discussion of the question of the primary standards of length which serve to define the ultimate units of reference, comparison with which, either directly or indirectly, constitutes the process of measurement of any other length. There are, as a matter of fact, three competing forms of primary standard—the " end " bar, whose length is determined by the distance between its end surfaces; the " line " bar, whose length is determined by the distance between two suitable graduation marks ruled upon it; and the so-called " natural " standard, based upon some physical constant independent of any material representation, *e.g.*, the length of the seconds pendulum. Each of these types in turn has at one time or another received legal recognition as a primary reference standard of length.

I have exhibited on the table upstairs a number of standards and models which will be of interest as indicating the progress that has been made. The earliest is the actual standard yard of Henry VII., an end bar of octagonal section, with roughly marked incisions representing inches up to one foot, and 1/16, 1/8, 1/4, 1/3 and 1/2

yard. It is worthy of note, as showing how well continuity has been preserved, that the length of this bar agrees within 0.04 inch with that of the present Imperial Standard Yard. On the other side of the picture we have the standard yard of Elizabeth, a square section bar which has been broken and crudely repaired by dowelling and binding the pieces together with two strips of sheet brass and copper wire. So far as can be judged, however, the length of the Elizabethan bar differed by no more than 0.01 inch from the present standard. It is astonishing to realise that this bar, in this condition, was actually the reference standard of England so late as 1824, when the first *Imperial* Standards were created. The new Imperial Standard Yard was generically a " line " standard, though the defining marks actually took the form of small dots instead of lines. It was laid down that the new standard, if ever lost or destroyed, should be replaced by reference to the " natural " standard of the seconds pendulum. The disaster thus provided for actually occurred unexpectedly soon, the new standard being destroyed in the fire in the Houses of Parliament in 1834. The Committee appointed to restore the lost standards soon found that it would not be possible to do so with as great accuracy by means of the seconds pendulum, as by reference to other bars known to have been compared with the lost standard. The natural standard was therefore abandoned, and the new (and present) Imperial Standard Yard, a true line standard, was completed in 1845, and given legal status in 1856.

The history of the metre shows remarkale analogies. Originally defined by means of a " natural " standard, the earth's polar quadrant, it was soon found necessary to abandon this owing to lack of precision, and to rely on a material representation, the Mètre des Archives, an end standard in the form of a flat rectangular bar of platinum. This in its turn was followed by the present International Prototype Metre, a line bar of X-section, made of platinum-iridium, with the defining graduations on the neutral surface of the cross-section.

There can be do doubt that in the state of the art as it existed in their day those responsible for the construction of the present standards of the yard and metre acted rightly in choosing the material line standard as affording the greatest advantage in accuracy of comparison and measurement. The materials used were also well chosen from the point of view of constancy in length. Many copies of both bars were made at the same time as the originals, and distributed to the various countries of the world, and various of the copies have been re-compared with the originals from time time. By the Weights and Measures Act of 1878 power was given to the Board of Trade to construct an additional bar as nearly as possible identical with the Imperial Standard Yard. The results of a number of comparisons of this later bar with a number of the earlier ones show that in the period of forty years which has elapsed since its completion it has shortened by about 0.0002 inch, and is now remaining constant, in relation to them. It is a reasonable deduction that the original bars themselves shortened by a similar amount in the forty years prior to the construction of the new bar, and have now steadied down to a constant value. There is nothing to indicate that any change has occurred in the absolute length of the present standard metre since its construction.

As regards accuracy of measurement, the lines on the yard bars, which are of earlier construction, are appreciably coarser than those on the metres. At the same time, it is worthy of record that the statutory decennial intercomparisons of the Imperial Standard Yard with its Parliamentary Copies in 1912 and 1922 exhibited no discrepancy exceeding 0.00002 inch, about one part in two millions of the total length. It has usually been assumed that with the better lines on the metre bars appreciably higher accuracy was attainable. Recent experience, however, has shown that it is not possible to get agreement of interpretation between different observers better than 0.00001 inch.

This figure, therefore, sets a criterion for any new development in the matter of ference standards, and it may safely be said that this degree of accuracy could be surpassed at the present day, either by a material end standard with ends finished optically flat and parallel by means recently developed, or by a natural standard based on the wave-length of light. A material representation of the standard is, of course, essential for all purposes of practical measurements, and for this an end standard is more readily determined than a line standard in terms of the wave-length, which, as an ultimate reference unit, has the two- fold advantage of being reproducible in any part of the world without risks

attendant upon the transportation of material standards, and also of being reproducible at long intervals of time without risk of change; and at their last meeting in 1923 the International Committee of Weights and Measures adopted in principle the eventual supersession of the present material prototype metre in favour of a wave-length standard. The national laboratories of the world are at present engaged on the investigations necessary to the formulation of a suitably controlled system based on this principle.

I commence by a description of the methods of construction and measurement of the new end standards, one of which is included in the exhibit upstairs.

These bars are produced by a method developed some seven years ago at the National Physical Laboratory by my then colleague, Mr. A. J. C. Brookes, and they are now being manufactured commercially by the Pitter Gauge and Precision Tool Company, Woolwich, under patents held by him. Some of them are on the table. The process is extremely simple. The bar, which is of circular section, is finished approximately to size, and is then mounted with its axis vertical in a special lapping jig above an accurately flat circular horizontal surface plate, with its under surface in the form of an annulus exactly parallel to the upper side. The base plate on which this annulus rests is adjustable, and by placing a sensitive level on the surface plate and adjusting until it can be rotated without alteration to the indication of the level, the upper surface is brought exactly horizontal. The bar to be finished is held at its two ends in adjustable clamps, in which it is capable of rotation. A sensitive level is attached temporarily to the bar, and the clamps in turn are adjusted until it can be rotated without alteration in the indication of the level. Its axis is then exactly vertical. A flat parallel lapping block is then worked between the surface plate and the end of the bar, with the result that its end is finished accurately flat, and exactly square to its axis. The bar is then turned upside down, and the other end finished in the same way, with the final result that the two ends are rendered both flat and parallel to each other with great precision. It has been possible in this way to produce bars with highly polished ends, both flat and parallel, with one or two millionths of an inch over the whole of a surface 7/8 inch in diameter, and with no errors in length exceeding the possible errors of comparison with the present-day line standards.

That great pioneer of industrial measurement, Sir Joseph Whitworth, who introduced the first end standards with any pretence of accuracy, also designed and constructed, in addition to the well-known Whitworth measuring machine, a special measuring machine nominally capable of comparing two bars to the accuracy of a millionth of an inch. It may be taken for granted, however, that not only were the bars of those days insufficiently regular in form for measurement to this degree of accuracy to be possible, but the principle of Whitworth's "millionth" machine was not such as to afford any real prospect of actual measurement to this accuracy. The next important advance in accuracy after Whitworth was due to Mr. C. E. Johansson, of Eskilstuna, Sweden, who in 1908 introduced the now well-known Johansson gauges. These consist of blocks or slips of hardened steel, with flat parallel end faces finished to such a high degree of accuracy that when perfectly clean they will adhere together by "wringing," without any magnetic or other attractive force. These gauges, which are arranged in series of appropriate sizes for the purpose, may be wrung together in groups so as to make up any desired size to the nearest ten-thousandth of an inch. To do this involves an accuracy of the order of 0.00001 inch in the individual gauges, which again demands the possibility of measurement, for the purpose of standardisation, to an accuracy of about 0.000001 inch.

INSTITUTION OF MINING AND METALLURGY AWARDS.

The following awards have been made :—

Gold Medal of the Institution—Emeritus Professor William Frecheville, in recognition of his services to the mining industry; "Consolidated Gold Fields of South Africa, Limited" Gold Medal and premium of 40 guineas—Dr. Sydney W. Smith, for his paper on "Liquation in Molten Alloys and its possible Geological Significance"; "Arthur Claudet" students' prize of 100 guineas—Mr. R. A. Mackay, for a paper on "The Influence of Superimposed Strata on the Deposition of Certain Lead-Zinc Ores."

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, March 24 :—

Interaction Between Ipsilateral Spinal Reflexes Acting on the Flexor Muscles of the Hind-Limb. By SYBIL COOPER, D. E. DENNY-BROWN AND SIR CHARLES S. SHERRINGTON, O.M., F.R.S.

Examination of the interaction between reflexes exciting the same muscle finds that the contraction they evoke when they are concurrent falls largely below the sum of the individual effects which they exert when apart. The effect of one of a pair of concurrent reflexes may default totally, *i.e.*, be totally occluded. Such " occluding " interaction is quite different from the inhibitory interaction of " antagonistic " reflexes. Its explanation seems that, at some structure impinged upon in common by the " allied " reflexes, (1) tetanic activation from one source precludes concurrent activation by a second, and (2) is not disturbed by the convergent activity of a second. Thus the occlusion is a functional aspect of the convergent overlap of " allied " reflexes upon " motor units " held in common; and the amount of occlusion is a measure of the degree of overlap.

The occluded contraction emerges from occlusion without pause and step for step as the occluding activation subsides, the afferent components of the one reflex smoothly substituting their activation of the motor units for that of the afferent components of the other reflex on a footing of equivalence; but each individual afferent excites in the muscle a reflex contraction which is of a pattern—a spatial configuration—specific to that particular afferent. It is shown that in the case of some of the afferent nerves examined the reflex evoked by full stimulation exhibits occlusion and inhibition admixed.

The Golgi Apparatus in the Cells of Tissue Cultures. By R. J. LUDFORD. Communicated by Dr. J. A. Murray, F.R.S.

The Golgi apparatus in the cells of tissue cultures undergoes a change in form with the spreading out of the cells on the surface of the cover-glass. As some cells spread out the Golgi apparatus is stretched until it fragments, and its individual particles become dispersed in the cytoplasm. In other cells the osmophil substance of the Golgi apparatus becomes spread in the form of rodlets, and granules upon a less deeply impregnated material (the idiosome, or sphere substance). Both substances become scattered together in the cytoplasm as the cells flatten out. It seems probable that they may eventually become dispersed to such an extent that the individual particles are below the limit of microscopic resolution. Certain of the fatty, or lipodial, globules in the cells of tissue cultures are considered to arise in relationship with the Golgi apparatus.

The Nature of Golgi Bodies and Other Cytoplasmic Structures Appearing in Fixed Material. By C. E. WALKER AND MARGARET ALLEN. Communicated by Sir John Farmer, F.R.S.

Golgi bodies and many chondrosomes are probably artifacts produced by demonstration methods. They do not appear if acetic acid is a component of the fixative. *Mitochondria, chondriosomes ,etc., do not appear* if more than a " trace " of acetic acid is used. All blacken with osmic acid.

If lecithin and kephalin are added to colloidal mixtures and films or drops fixed without using acetic acid, structures exactly resembling Golgi elements, etc., are produced. Mitochondria, etc., are also represented. These structures also do not appear if acetic acid is used in fixative. These artificial structures behave in same way as Golgi apparatus, etc., when treated with osmic acid and when washed with turpentine.

On adding oleaginous emulsions to the colloidal mixtures, the structures produced by fixation and osmication appear to behave in a similar manner in relation to the globules of the emulsion as do Golgi elements, etc., to the nucleus of the cell.

The Giant Cells in the Placenta of the Rabbit. By G. S. SANSOM. Communicated by Prof. J. P. Hill ,F.R.S.

Two kinds of giant cells are found in the uterus. The larger are derived from the fœtal trophoblast, cells from which penetrate into the obplacental mucosa. These cells rapidly attain enormous size, persist till about the 22nd day, and then break up into smaller bodies. Large numbers of these cells are also formed from that portion of the trophoblast of the proximal zone of the bilaminar omphalopleure, which projects free into the uterine cavity after the attachment of the blastocyst to the placental folds on the 8th day. The cells proliferated from this " trophoblastic fringe " pass into the uterine cavity and penetrate the regenerated uterine epithelium.

NOTICES OF BOOKS.

Doubling our Coal Power.

This is the title of a pamphlet by A. Allport, price 6d., from Wadsworth & Co., Keighley, Yorkshire. The author sets out the advantages to be gained by low temperature carbonisation. This, he claims, is a proved commercial proposition and offers a lasting solution of the mining problem.

It eliminates waste and extracts scientifically at the lowest possible cost the utmost value from the coal. Appendices of relevant matter are included to support these views.

The author of this pamphlet is a well-known physician and surgeon, who, in the interests of health and industrial efficiency, has made a close and constant study of fuel economy from upwards of 15 years.

He invites attention to the pamphlet, which has been prepared and circulated entirely at his own expense, in view of the urgency of the subject at the present juncture.

Anorganische Chemie. Von Dr. Robert Schwarz. Pp. xii. + 140. Dresden and Leipzig : Theodor Steinkopff. 1927. Price, unbound, 8 marks; bound, 9 marks 20 pf.

One of the difficulties which beset any author of an *Inorganic Chemistry* at the present time is to determine where the subject ends and passes into another branch of the science, such as physical chemistry, applied chemistry, mineralogy, or geochemistry. This difficulty becomes increasingly emphasised when, as in the present instance, the author deals most particularly with the recent advances in the subject. Dr. Schwarz, however, has had his task simplified by the fact that his volume is number 16 of Prof. Liesegang's Scientific Monographs which are being published by Messrs. Steinkopff, consequently other authors are dealing with the alliled branches of chemistry, and Dr. Schwarz is thereby restricted to the field of purely inorganic chemistry.

He commences with a General Introduction, summarising recent work on the atom and the new elements. The individual elements, first the non-metals and then the metals, are next considered in Periodic order, with special reference to the latest knowledge of their properties, reactions and new compounds.

This is followed by two chapters on complex compounds, in which auxiliary valencies, an the nature of the ammines, *etc.*, are discussed.

It would appear that the author has made a critical study of recent literature, although he does not seem always to have studied *original* English contributions, and this is responsible for one or two minor slips. These, however, hardly detract from the value of a very useful book.

J. G. F. D.

The Oil and Colour Chemists' Handbook. A Technical Reference Book, with many Tables for the Paint and Varnish Industry. Pp. 176. Price 10s. 6d. London : The Trade Papers Publishing Co., Ltd., 320, High Holborn, W.C.1.

This is a translation of a German work, which is considered to be one of the best books of the kind.

Text Book of Bioligical Chemistry. By James B. Sumner, Ph.D. (Assistant Professor of Biological Chemistry at Cornell University, Ithaca, New York. Pp. xxiii. + 284. Price 15s. net. London and New York : Macmillan and Co.

Intended specially for the elementary student, the author had perforce to indulge in drastic condensation, so as to keep the work in handy s ize. There is given besides a good index at the end of the work, a serviceable table of contents at the beginning, so that reference to any particular item of information is quite simple.

Van Nostrand's Chemical Annual. (A Handbook for Useful data or Analytical, Manufacturing and Investigating Chemists, etc.) Edited by John C. Olsen, A.M., Ph.D., D.Sc. Pp. xv. + 882. Price 21s. London : Chapman and Hall, Ltd.

The present is the sixth issue of this compact work, which is packed full of varied and useful information. Each new issue seems to grow in size and usefulness, because of the new tables and other matter added to the text, an effort being made to keep up to the various discoveries and amendments that are made from time to time in the chemical and scientific world. There is given a pretty full list of new books issued since the last edition, and while it would be impracticable to index fully a book of such varied information, there is yet given a good general index. It is, on the whole, a very good book of reference.

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1925-1926 (*Cmd.* 2782.) Royal 8vo.; paper wpr.; pp. iv + 178. Price net. Postage extra.

This publication gives an account of the work of the Department of Scientific and Industrial Research during the year ended 31st July, 1926. It is divided into the following main sections :—

Report of the Committee of Council.
Report of the Advisory Council.
Summary of the Work of the Research Organisations of the Department.

The report is supplemented by detailed appendices giving particulars of Research Boards and Committees of the Department; statistics of grants made to individual research workers; lists of aided researches; summary of finance; information concerning Research Organisations; developments in the organisation of research in other parts of the Empire; list of publications by individuals in receipt of grants; list of papers b scientific staffs of Admiralty, War Office and Air Ministry during the year; and a list of the Department's publications issued, or in the piess, during the year. The report is indexed.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

21, Albemarle Street.

Tuesday, April 5.—" Some Properties of Coke." By John W. Cobb, C.B.E., B.Sc., Livesey Prof. of Coal Gas and Fuel Industries, University of Leeds.

Thursday, April 7, at 5.15 p.m.—" The Beginnings and Early Spread of Agriculture." By Mr. Harold Peake.

Friday, April 8, at 9 p.m.—" Early Days *in Radio-Activity.*" *By Sir Ernest* Rutherford.

Saturdays, April 2, and 9.—" The Alpha Rays and their Application to Atomic Structure." By Sir Ernest Rutherford, O.M., LL.D., D.Sc., Pres.R.S., M.R.I., Prof. of Natural Philosophy, R.I., and Cavendish Prof. of Experimental Physics, University of Cambridge.

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Thursday, April 7, at 6 p.m.—E. B. Wedmore, W. B. Whitney, B.Sc. (Eng.), and C. E. R. Bruce, M.A., B.Sc. : " A Contribution to the Study of the Number of Tests required to establish the Rupturing Capacity of an Oil Circuit-Breaker." (To be illustrated by a cinematograph film.)

North-Western Centre, 17, Albert Square, Manchester.—Tuesday, April 5, at 7 p.m.—Annual General Meeting. F. H. Clough, C.B.E. : " The Stability of Large Power Systems."

SOCIETY OF PUBLIC ANALYSTS.

The next meeting of the Society will be held on Wednesday, April 6, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m. The following papers will be read :—

" The Sequence of Strokes in Writing." By C. Ainsworth Mitchell, M.A., F.I.C., and T. J. Ward.

(i) " Some Observations on the Wasting of Gluten from Flour." (ii) " A Numerical Expression for the Colour of Flour." By D. W. Kent-Jones, Ph.D., B.Sc., F.I.C., and C. W. Herd, B.Sc., F.I.C.

" The Determination of Free Mercury in Commercial Products." By H. B. Dunnicliff, M.A., Sc.D., F.I.C., and Kishen Lal, M.Sc.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

PATENTS.

Latest Patent Applications.

6,711.—Appareils et Evaporateurs Kestnet.—Recovery of caustic soda from residual lyes. March 10th.

6,723.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of vat dyestuffs. March 10th.

6,891.—I. G. Farbenindustrie Akt.-Ges. Nitration of dianthrone, etc. March 11th.

6,452.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of organic compounds. March 8th.

Specifications Published.

266,771.—Farbenfabriken vorm. F. Bayer & Co.—Manufacture of azo-dyestuffs.

266,777.—British Celanese, Ltd., and Ellis, G. H.—Treatment of cellulose acetate or products made therewith.

266,820.—Stickings, R. W. E., and May, and Baker, Ltd.—Manufacture of basic bismuth salts of aryl-arsinic acids.

249,160.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of dyestuffs of the triaryl-methane series.

267,018.—I. G. Farbenindustrie Akt.-Ges. —Process for the decomposition of hydrogen sulphide and for its removal from industrial gases. *Abstract Published.*

264,724.—Sodium monoxide.—Roessler & Hasslacher Chemical Co., 709, 6th Avenue, New York, U.S.A.

In the production of sodium monoxide according to the parent Specification by the oxidation of sodium with air or oxygen in the presence of a large proportion of finely divided sodium monoxide, the oxygen is supplied at such a rate that a constant temperature below the vapourization point of sodium is maintained. Only so much sodium is present at any time that, when melted it is absorbed by the monoxide without formation of a paste. During the reaction the materials are agitated and the sodium may be added continously while the product continously withdrawn.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

CODILAX.

452,470.—Chemical substances used for agricultural veterinary and sanitary purposes. — Seedolin Company, Limited, Hope's Wharf, 21, Lower Mall, Hammersmith, London, W.6. March 16th.

ALEXOCAIN.

476,221.—Anaesthetics for human use in the extraction of teeth.—John Samuel Gould, 62, Mount Pleasent, Liverpool. March 16th.

PARSTAFFS.

477,422.—Chemical substances prepared for use in medicine and pharmacy. James Parker, 43, Cope Street, Leamore, Walsall. March 16th.

ONAL.

477,801.—Chemical substances prepared for use in medicine and pharmacy. — Adolphus Gillis, 129, High Street East, Sunderland. March 16th.

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THE STRUCTURE OF AN ATOM OF NITROGEN.

By HAWKSWORTH COLLINS, B.A. (Camb.).

In the year 1914 fourteen hundred diagrams, each concerning one substance, were sent to the Nobel Institute. These diagrams demonstrated the relative volume of each atom in the several substances. The elements concerned in that particular matter were H, C, O, S, N, Cl, Br, and I.

Four distinct volumes were found for H, each one belonging to a particular position with regard to the carbon atom. Two of these volumes were 15.25 and 5.76. The carbon atom was found to have two volumes, 0.71 when each valence is united to a different element as in CH_4; and 8.0 when two or more valences are joined to the same element as in CO.

Nitrogen was found to have three volumes, 0.71, 15.96 and 21.72. These results, fully demonstrated, were accompanied with the observation that

$$15.96 = 0.71 + 15.25 + 0$$

and $$21.72 = 0.71 + 15.25 + 5.76$$

so that nitrogen is apparently compounded of an atom of carbon united to two atoms of hydrogen. the latter being like bubbles on a speck of carbon. The H-portions can either be both expanded together as in 21.72, or only the larger one as in 15.96, or they can both be absorbed completely by the C-portion as in 0.71.

It was considered very remarkable that the volumes of N should indicate that its composition is CH_2 whilst the atomic weights do the same ($14 = 12 + 2 \times 1$).

This structure for an atom of N was confirmed five years after by Sir E. Rutherford, who actually knocked off the two H-portions by bombardment.

When this was generally known, a paper was published by the *Chemical News* showing that if an N-atom in the gaseous state were similar to that found in the liquid and solid states, and if it were bombarded by Sir E. Rutherford's method, the two H-portions would be likely to be torn from the C-portion. It would be like a sudden gust of wind tearing a balloon from the hands of a group of men before they could overcome the inertia of their bodies, the balloon being about 30 times the size of the group of men, but only a sixth part of their weight.

It is difficult to see how any further knowledge with regard to an atom of nitrogen can be obtained by Sir E. Rutherford's method, *i.e.*, by direct experiment, but it will be shown in the following mathematical thesis that a great deal more can be discovered indirectly by correct reasoning upon all the wonderfully exact experiments of many scientists in several directions.

In addition to Specific Gravity. Molecular Weight, and Structure of Molecules, which give Relative Volume, the following eight lines of direct experiment will be employed :— Optical Refractivity, Magnetic Rotation, Heat of Formation (gaseous, liquid, aqueous and solid), Heat of Combustion of the original element, and H.C. of the molecule.

As the investigation also frequently involves matters of Mathematics and Mineral-

ogy, besides Physics and Chemistry, it is evident that no man who is an expert in any one of these without knowledge of the others can undertake such an investigation. It can only be done by a nonentity who has some general knowledge of them all.

Besides this, it is absolutely necessary that the investigator should not be himself an experimentalist; otherwise he might be inclined to juggle with his own experimental figures, a state of affairs which has frequently occurred in the past.

The method of proof that N = CH_2 is similar to those of the 29 elements which have been published in the *Chemical News* during the last three years. Later papers will give the experimental data from which the relative volumes of N have been obtained. Each one of these volumes is shown in Table I. to split up into previously demonstrated volumes of C and H. The results will then be confirmed whenever the experimental result is available, by the eight distinct series of experimental data mentioned above.

TABLE I.

The Relative Volumes of Nitrogen.

N	=	C	+	H	+	H
0.83	=	0.71	+	0.06	+	0.06
3.8	=	0.71	+	0.06	+	3.03
6.53	=	0.71	+	0.06	+	5.76
9.5	=	0.71	+	3.03	+	5.76
12.23	=	0.71	+	5.76	+	5.76
16.02	=	0.71	+	0.06	+	15.25
21.72	=	0.71	+	5.76	+	15.25

TABLE II.

Physical Constants of Nitrogen at 15° C.

Relative Combining Volume	H.C. gas	H.C. of Orig. Elem.	H.F. gas	H.F. liq.	H.F. aq.	H.F. solid	M.R.	O.R.
0.83	20500	0	-20500	-20500	-23630	-20500	0.49	2.493
3.8	20500	0	-20500	-20500	-23630	-23630	3.68	3.8
6.53	20500	0	-20500		-30390	-54014	1.47	2.493
9.5	23630	0	-23630	-87070		-87070	0.735	2.8
12.23				-30390		-117460		3.265
16.02	0	0	0	-54014	-54014	-54014	0.437	3.8
21.72	117460	0	-117460	-117460	-117460	-117460	0.322	2.8

TABLE III.

The Heat of Formation of Nitrogen.

Equiv. Orig. Vol.	Relative Combining Volume	Change of Volume	H.F.		The Law.				
1.677	3.8	-2.123	-23630	=	795	×	(-2.123)	×	14
1.677	6.53	-4.853	-54014	=	795	×	(-4.853)	×	14
1.677	9.5	-7.823	-87070	=	795	×	(-7.823)	×	14
1.677	12.23	-10.553	-117460	=	795	×	(-10.553)	×	14

TABLE IV.

Physical Constants at 15° C. of H, O, C, S, P, Cl, Br, I, F (the elements chiefly involved in N-compounds).

Elem.	Relative Com-bining Vol.	H.C. gas	H.C. of Orig. Elem.	H.F. gas	H.F. liq.	H.F. aq.	H.F. solid	M.R.	O.R.
H	15.25	27100	34380	7280				0.235	0.985
H	12.22	27853	34380	6527				0.265	1.125
H	0.95	27194	34380	7186				0.165	1.125
H	5.76	26375	34380	8005	8005		8005	0.399	0.82
H	0.97	18285	34380	16095				0.5175	
H	8.59	(ionised,	acidic)		-24350	-24350			
H	5.76	(ionised,	basic)		-15300	-15300			
O	7.53	-32341	0	32341	32341	32341	32341	0.042	1.654
O	4.45	-71515	0	71515	71515	71515	71515	0.315	1.747
O	2.51	-96155	0	96155	96155	96155	96155	0.202	1.346
O	0.836	-117460	0	117460	117460	117460	117460		

C	0.71	104218	96148	-7800	-7800	-7800		0.459	2.6685
C	8.0	128496	96418	-32078	-13855	-13855	-13855	0.633	3.333
C=C	1.42	208436	192836	-15600				3.364	6.666
C=C	1.42	223844	192836	-31008				2.772	6.107
S	15.53	86429	70899	-15530	6217	0	6217	0.515	8.0
S	15.53				0	0	0	0.515	8.0
S	10.51						19277		8.67
P	14.56					8598	8593		
P	16.87					-8593	-8593		
P	14.56						0		
P	10.51						23659		
Cl	15.085	-14500	0	14500	56786	63870	56786	3.932	
Cl	23.01	-8127	0	8127	23010		23010	1.645	5.94
Br	23.09					52930	45244	7.95	
Br	27.0	-895	0	895	7653			3.59	8.695
I	32.77	11968	0	-11968	-4238		7010	7.756	13.878
I	27.75	14097	0	-14097		37720	36226	17.83	
F	5.42					77500	76820		

Table V.

Heat of Combustion of H. C. and S in their original states at 15° C.

H_2O (liq.) -2(24350) + 117460	=	68760	=	2(34380)
Thomsen		68360	=	2(34180)
Berthelot		69000	=	2(34500)
CO_2 (gas) -32078 + 96155 + 32341	=	96418		
Favre		96960		
Gottlieb		96400		
SO_2 (gas) 6217 + 2(32341)	=	70899		
Thomsen		71080		

Table VI.
The Law of Magnetic Rotation *re* Nitrogen.

Rel. Combining Vol.	M.R.		Law		
9.5	0.735	=	7	÷	9.5
16.02	0.437	=	7	÷	16.02
21.72	0.322	=	7	÷	21.72

The Tables given here must of necessity be employed by any one who wishes to follow the intricate interdependence of physico-chemical facts, which will be given in later papers, and which will gradually make plain the structure of an atom of nitrigen.

Since 1914 it has been found that the lowest relative volume of N is 0.83, not exactly the same as that of C (0.71).

Each one of the 12 H-portions which form C (0.71) has a relative volume slightly less than 0.06. 12 × 0.0592 = 0.71. Also each one of the 14 H-portions which form N (0.83) has the same volume (14 × 0.0592 = 0.83); so that the wording of the discovery of the structure of an atom of N now stands as follows : —An atom of N has been formed by the atomisation of 14 atoms of H, 12 of which form an atom of carbon, and the remaining two can be expanded into volumes which have previously been demonstrated to be volumes of H.

Fortunately the relative volumes of H differ widely from one another (0.06, 0.303, 5.76, 9.95, 12.22 and 15.25) so that it is easy to distinguish them.

The volume 3.8 of N will be demonstrated first, and (see Table II.) whenever the element has this volume, the H.C. gas must be 20500, the H.F. both in the gaseous and liquid states must be -20500, the H.F. in the aqueous and solid states must each be -23630; its M.R. must be 3.68, and its O.R. must be 3.8. Similar remarks apply to each line of constants in Tables II. and IV. In this way any particular form of each atom can be distinguished in eight or nine different ways.

In Tables II. and IV. the algebraic sum of the Heat of Combustion and Heat of Formation of any atom in the gaseous state is equal to the Heat of Combustion of the original form of that atom.

It is useless attempting to explain anything further by mere statements as the matter can only really be elucidated by means of experimental facts arranged in certain ways.

The whole matter is confirmed by the *fact that there have* only been five important experimental discoveries with regard to the Structure of Atoms, all made by British scientists during the last fifteen years, and every one of these discoveries was published as a theoretical discovery by the present writer in each case *at least five years before* the corresponding experimental discovery.

The word "publish" here includes the free gift of them in type-written form to leading British scientists.

The advantage of the theoretical method of discovery is that it makes plain a great many facts that are unobtainable by direct experiment.

As the figures given by chemists for the Specific Gravity of a substance frequently do not agree to the second decimal place. very seldom to the third, and only by accident to the fourth, it is unreasonable and misleading to record the third and fourth experimental decimal places in an investigation of this kind, so that the experimental results are here (*i.e.* in later papers), generally given to the nearest hundredth of a unit.

DIETHYL SULPHATE IN THE EXAMINATION OF HYDROCARBON OILS.

By J. N. TAYLOR.

(Biochemic Division, Bureau of Animal Industry, Washington, D.C.)

Paraffins and naphthenes are usually differentiated from aromatic and unsaturated hydrocarbons by sulphonation. The procedure described by Chapin, in which dimethyl sulphate is employed, is often used in a preliminary examination of such mixtures.

As it is poisonous, dimethyl sulphate may be safely used only if carefully handled. Diethyl sulphate, its homologue, is reported to produce no toxic effects, which would appear to give it an advantage. In order to determine its efficiency when applied to mixtures of hydrocarbon oils, tests were made and the results compared with those obtained by the use of dimethyl sulphate and of sulphuric acid.

Mixtures, in varying proportions by volume, of petroleum oil and benzene were prepared. The petroleum oil was a high-boiling, refined petroleum distillate, with an initial boiling point of 265° C., and a specific gravity of 0.858 at 25° C. It was immiscible with both dimethyl and diethyl sulphate and was unacted upon by concentrated sulphuric acid. The benzene employed was "commercially pure benzol." Its boiling range was within 2° C., and included the true boiling point of benzene. It had a specific gravity of 0.870 at 25° C., was completely miscible in all proportions with both of the alkyl sulphates, and left no residue upon sulphonation. The alkyl sulphates used were refined grades, with but a trace of acidity.

Five c.c. of the mixtures and 8 c.c. of the alkyl sulphates were placed in glass-stoppered Egertz tubes. The tubes were vigorously shaken and placed in a constant-temperature water bath and the volumes of the resulting upper layers were measured at 25° C. Upon completion of sulphonation the volumes of the oil residues were measured at 25° C.

TABLE I.

ALKLYL SULPHATE RESIDUES FROM BENZENE-PETROLEUM MIXTURES COMPARED WITH SULPHONATION RESIDUES IN PERCENTAGES.

Petroleum Oil present	Sulphonation Res.	Dimethyl Sulphate Res.	Error	Diethyl Sulphate Res.	Error
10	10	8.5	-15.0	0	-60.0
20	20	22.3	11.5	8	—
30	30	35	16.7	23	-23.3
40	40	46.7	16.8	36.2	-9.5
50	50	57.5	15.0	48.3	-3.4
60	60	67.1	11.8	60.4	0.7
70	70	76.1	8.7	70.2	0.3
80	79.6	84.9	3.2	90.5	0.6
90	90	92.9	6.6	80.9	1.6

In its upper range, the partition curve for diethyl sulphate is in close agreement with the sulphonation curve. In the lower range there is a deviation. As a change in the relative masses of the components of a ternary mixture affects the equilibrium of the system, it was thought that the diethyl sulphate curve could be flattened by increasing the quantity of petroleum. The procedure was therefore slightly modified.

TABLE II.

DIETHYL SULPHATE RESIDUES (MODIFIED METHOD) COMPARED WITH SULPHONATION RESIDUES.

Petroleum Oil Present	Sulphonation Res.	Diethyl Sulphate Res.	Error
10	10	11.2	12.0
20	20	22	10.0
30	30	33.6	11.7
40	40	44.2	10.5
50	50	54.2	8.8
60	60	63.4	5.7
70	70	73.4	4.9
80	79.6	83	3.8
90	90	90.6	0.7

In the Egertz tube was first placed 5 c.c. of the petroleum oil previously described, containing no aromatic or unsaturated hdrocarbons. Then 5 c.c. of the mixture under examination were added, followed by 16 c.c. of diethyl sulphate. After agitation, the tubes were placed in the bath and the volumes of the upper layers noted. The percentage residue was calculated by subtracting 5 from the reading and multiplying the result by 20. Table II gives the results obtained.

The diethyl sulphate curve does not follow the sulphonation curve as closely as was hoped. The error due to mutual solubility is augmented by those introduced as a result of the modification in technique. The additional reading made necessary when the petroleum oil is placed in the tube at the outset constitutes an opportunity for error, and if all three readings are made by interpolation the likelihood of additional errors presents itself, especially when the residue is small. Again, on calculating percentage results, the error is multiplied by 20. However, the final error is reduced when the percentage of residue in the oil is calculated to the percentage amount in the dip from which the hydrocarbon oils may have been extracted.

Hydrocarbons having properties similar to those of the saturated hydrocarbons found in certain petroleums also occur in the creosote derived from tars produced during the carbonisation of coal at low temperatures (500° to 600° C.). A dip was prepared containing creosote of this character. The oily components were extracted and tested with diethyl sulphate by the modified method.

The neutral oils obtained from a number of animal dips and sprays which had been submitted to the laboratory for analysis were also examined by the modified method. The results are given in Table III.

TABLE III.

SATURATED HYDROCARBON RESIDUES FROM OILS EXTRACTED FROM COMMERCIAL SAMPLES (PERCENTAGES).

Diethyl Sulphate Test (modified method) compared with sulphonation.

	Sulphonation Res.	Diethyl Sulphate Res.	Error.
(a)	68	67	-1.5
(b)	48.3	48	-0.6
(c)	72	72	0.0
(d)	14	14	0.0
(e)	74	75	1.3
(f)	64	65	1.5
(g)	65.4	67	2.4
(h)	8	8.2	2.5
(i)	66	68	3.0
(j)	77	80	3.9

CONCLUSIONS.

Diethyl sulphate is useful in differentiating paraffins and naphthenes from aromatic and unsaturated hydrocarbons. The method of employing it is not as simple as the procedure which calls for dimethyl sulphate. Diethyl sulphate, however, is thought to be safer than dimethyl sulphate.

The procedure employing diethyl sulphate affords results comparable with those obtained through sulphonation.

The method is applicable to commercial hydrocarbon oil mixtures and to articles from which such oils can be extracted.
—(Abstracted from *Industrial and Engineering Chemistry*, 1927, XIX.,76.)

General Notes.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF KEY INDUSTRIES.

The Board of Trade give notice that representations have been made to them under Section 10(5) of the Finance Act, 1926, regarding the following articles :—*Dial (acid di-allyl barbituric); Elbon (cinnamoyl para-oxyphenylurea)*; Integrators (planimeter type); R. Lead acetate; Lipoiodin (ethyl di-iodo brassidate); Phytin (Calcium magnesium inosite hexaphosphate); Planimeters.

PETROLEUM BISULPHIDE OF CARBON.

The Secretary of the Home Department has made an Order in Council regulating the conveyance of the above by road. Among other points it says that

1. Bisulphide of carbon shall not be conveyed except

(*a*) In steel or iron containers each of a capacity not exceeding 50 gallons, constructed in accordance with the specification contained in the Schedule, maintained in good condition and securely closed so as to prevent leakage, or

(*b*) In luted and tied-over stoppered bottles, each containing not more than 7 lbs., securely packed in strong wooden cases in sawdust, kieselguhr, or other suitable material. Each bottle shall be separated from other bottles by wooden partitions and the total weight of bisulphide of carbon in any one case shall not exceed 80 lbs.

2. Containers and cases containing bottles shall be packed so as not to project beyond the sides and ends of the vehicle.

3. Containers shall be loaded and carried bung uppermost. When the bung is in the side of the container as in the case of barrels and large drums, each container shall, unless packed in a strong wooden perforated case or crate, be carried on a cradle. The load shall be secured to the vehicle by ropes or otherwise, unless sides and back of adequate height are provided.

CALCIUM CARBIDE EXPORTS DURING 1926.

Canadian exports of Calcium Carbide during 1926 reached 445,861 cwts. valued at $1,717,780, as compared with the previous year's total amounting to 335,143 cwts. worth $1,317,117.

THE WINTER IN CANADA.

LIVESTOCK.

Atlantic Provinces :—An open fall has been followed by a mild open winter. Farm animals are reported generally to be in good condition.

Quebec.—Mild weather prevailed throughout January. Cattle are everywhere reported to be in a healthy condition with an adequate supply of feed. The average value of horses is somewhat better than a year ago. Prices for sheep and swine have maintained the same level whilst milch cows show a slight decrease. Returns for poultry are satisfactory. Hired help is mostly used in rush times and paid for by the day.

Ontario.—Live stock are wintering well and are healthy. Feed scarcity is reported from only a few districts and in these a smaller number of young cattle are being fed.

Manitoba.—The winter has been cold with much snow, and it has been necessary to do a great deal of feeding under shelter. Most districts state that feed is scarce and very dear. The heavy snowfall assures moisture for the early part of the crop season. There are good openings for the right type of farm help, both male and female.

Saskatchewan.—Although heavy snow in all parts of the province, except the southwest, is making this a hard winter for cattle and horses running out, so far the stock are coming through in fairly good condition. Feed is scarce and a shortage is feared if the winter is prolonged.

Alberta.—Live stock have wintered in fair condition with no losses of any consequence. The supply of fodder is generally sufficient.

British Columbia.—There is sufficient feed in all sections to carry over the winter. The demand for milch cows and swine is brisk. Poultry are steady with dump duty on eggs steading industry.

AVERAGE VALUES OF CANADIAN FARMS.

According to the 1926 annual estimates of the Dominion Bureau of Statistics at Ottawa the average value of the occupied farm lands of Canada as a whole, including both improved and unimproved land, as well as dwelling houses, barns, stables and other farm buildings, is returned as $37 per acre, as compared with $38 in 1925 and with $37 in each of the two previous years.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read on Thursday, March 10,1927, at 4.30 p.m. :—

The Viscous Elastic Properties of Muscle. By A. Levin and J. Wyman. Communicated by Professor A. V. Hill, F.R.S.

The mechanical properties of various muscles are analysed and described in terms of elasticity and " viscosity." The latter term, of a complex nature, denotes the irreversible processes which cause of a loss of work, greater with greater speeds, and prevent the muscle from contracting instantaneously. With the help of a special myographion the muscles were allowed to shorten, or were stretched, at various constant speeds, and tension-length diagrams were recorded. A mechanical model was constructed, by which the curves, produced by the muscle, could be closely imitated. This model consists of two elastic elements (springs), of which one is damped, and the other not, and it is argued that the muscle is mechanically a system of this type.

When the muscle is stimulated isometrically, tension is set up in it, which is shared by the damped elastic and free elastic elements. When the muscle is then released at a constant rate, the damped elements lag behind, causing thereby a drop of tension, which. however, is not instantanous, owing to the presence of the free elastic elements. As the shortening proceeds, a steady state of lag is reached exponentially When the release stops, the damped elements continue to shorten, stretching the free elements, and the tension redevelops exponentially. In a stretch the events occur in the opposite order.

The actual contractile structures are the damped elements, and the theory explains the substantially exponential form of the tension-time curve of an isometric contraction by assuming that on stimulation the damped elements change suddenly their elastic condition and begin to shorten, stretching the free elements.

The free elastic elements perform an important physiological function in acting as " buffers," which smooth the strains and prevent the tension from falling instantaneously when the muscle rapidly shortens a small amount.

Ovarian Regeneration in the Mouse after Complete Double Ovariotomy. By A. S. Parkes, Una Fielding, and F. W. R. Brambell. Communicated by Prof. J. P. Hill, F.R.S.

Of 121 double ovariotomised mice, all of which showed initial cessation of the œstrous cycle, 11 subsequently showed signs of spontaneous œstrus. In eight of these eleven cases the presence of new ovarian tissue was demonstrated histologically.

Since the operation of ovariotomy consisted of removing the ovaries, capsules, and the top portions of the Fallopian tubes, it seems evident that the regeneration of ovarian tissue took place from non-ovarian structures, but the exact site of regeneration could not be ascertained from the material available.

In most cases follicles and corpora lutea were found in the regenerate tissue, and in most cases also these cyclic structures of the regenerate tissue could be correlated with the recent œstrous history of the animal. In one or two cases, however, the fewness of these cyclic structures seemed to make it clear that the previous œstrous periods observed had not been brought about by the maturation of successive batches of follicles. This applies in particular to two animals which were sterilised by X-rays as soon as regeneration had begun.

Most of the regenerate animals had a normal cycle after the first spontaneous appearance of œstrous symptoms, but in at least one case a very irregular series of œstrous-like phenomena occurred, prolonged cornification being the chief feature observed.

The Relation between " Density " of Sperm-Suspension and Fertility as Determined by Artificial Insemination of Rabbits. By A. Walton. Communicated by Dr. F. H. A. Marshall, F.R.S.

1. Experiments on artificial insemination of rabbits show that fertility is influenced by the density or number of spermatozoa introduced into the vagina of the female.

2. The percentage fertility is reduced where the estimated number of spermatozoa is less than about 10^6 per 3 c.c. Sterility occurs where the number is below 10^4 per 3 c.c.

3. Three factors probably play a part in determining the results, but are not subject to separate quantitative estimation :—(*a*) The probability of any one spermatozoon reaching the fertilisable ovum is small. (*b*) The spermatozoa are variable and not all

capable of fertilisation. (c) Toxicity may act differentially on sperm-suspensions of varying density.

4. The bearing of these experiments on the problem of fertility is discussed, and the quantitative basis of fertility, as far as the influence of the male is concerned, is advanced as a working hypothesis for future inquiry.

The following papers were read in title only :—

The Action of Glucosone on Normal Animals (Mice) and its Possible Significance in Metabolism. By ALEXANDER HYND. Communicated by Sir James Irvine, F.R.S.

The present position of the reactive forms of glucose in carbohydrate metabolism is reviewed, and the possible importance, in this connection, of *glucosone*, a first oxidation product of glucose, is indicated.

Methods for production of this compound in purified form are outlined, and experiments described which demonstrate that the subcutaneous injection of glucosone, in appropriate dosage, produces in normal mice, a condition similar to that caused by insulin. The physiological activity is specific for glucosone, as no effect is manifested by either maltosone or lactosone.

There is a close parallelism between the action of glucosone and of insulin, for not only is there a striking similarity between symptoms produced in the two cases, but their development also is modified or inhibited by an injection of either adrenaline or pituitrin. The "glucosone effect," however, is not remedied by the administration of glucosone. Reasons for this are discussed.

The observation that an injection of acetoacetic acid antagonises the effect of a glucosone injection indicates that glucosone may be of significance in fat metabolism. Glucosone, it is suggested, is formed by action of insulin on blood sugar, and thus may be an important compound in the intermediate metabolism of carbohydrates.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Applications of Electricity in Warships. By WILLIAM MCCLELLAND, C.B., O.B.E., Member.

INTRODUCTION.

This paper surveys the applications of electricity in warships and presents a general review of the subject. Space does not permit of any particular phase being investigated in considerable detail, whilst certain items of technical research are left untouched or undeveloped on account of their confidential nature.

The paper consists of two parts, subdivided as follows :—

Part I.—General.—Introduction; Types of warships; Historical survey of electrical development, and the Washington Treaty.

Part II.—Applications — Special problems in naval electrical engineering; Type of supply (alternating or direct current); Syetem of distribution; Branches of electrical work; Machinery; Lighting; Searchlights; Heating, cooking and baking; Cables; Insulating materials; Secondary batteries; Submarine problems; Wireless telegraphy and telephony; Fire control, torpedo control, telephones, and miscellaneous low-power apparatus; Electric propulsion; Miscellaneous; Conclusion.

TYPES OF WARSHIPS.

The development of present-day warships may be retraced through a succession of types to the Grecian Homeric age, *i.e.*, about 1000 B.C.; the gradual evolution of oared ships of war from this period, through the Grecian, Phœnician and Persian merchant and war craft may be observed through stages such as the Roman trireme with its three decks of oars to the war galley type of craft, which about A.D. 840 took part in the earliest English naval engagements. There were succeeded by more elaborate ships using oars and/or sails.

A succession of revolutionary changes came during the nineteen century. These were, in historic order, steam (about 1837), the screw propellor (1845), explosive shell (1858), iron ships (1860), gun turrets (about (1860), electricity (1874), steel armour plate (about 1895), and, in 1905, the building of the "Dreadnought," which crystallised all the lessons of the previous century of change and was the prototype of the modern battleship.

Modern warships may be divided into two types, and each type into classes. The main types are battleships, battle cruisers, cruisers, aircraft carriers, destroyers and submarines.

The battleship is a floating fortress. She is heavily armoured, and carries the most powerful guns, speed being secondary. The "Iron Duke," the flagship of the Grand Fleet during the early part of the war of 1914-1918, was designed for 21 knots, and 29,000 s.h.p. (shaft horse-power).

Battle cruisers are ships having the armament of battleships, but in which armouring is sacrificed to speed. The battle cruiser "Hood" has a designed speed of 31 knots with 144,000 s.h.p.

The cruiser is of smaller displacement than the battleship, lightly armoured, and designed for high speed, *e.g.*, "Emerald," of 7,600t ons, 33 knots, and 80,000 s.h.p.

The aircraft carrier has resulted from the use of the aeroplane in naval warfare. "Lexington," and "Saratoga," the new aircraft carriers of the United States Navy, have turbo-electric propelling machinery developing a speed of about 35 knots and 180.000 s.h.p., equivalent to the output of a modern super-power station.

The destroyer is smaller than the cruiser, designed for high speed, and, in the main, for torpedo warfare, with, say, a displacement of 1,300 tons, speed about 34 knots and 27,000 s.h.p.

Submarines are capable of being propelled either on or below the surface of the water. Since their first introduction, submarines have continuously increased in size, speed, and fighting power.

Auxiliary warships include depot ships, repair ships, monitors, minelayers, coastal motor boats, river gunboats, sloops and hospital ships.

Historical Survey of Electrical Development.

Electricity in the British Navy dates from 1874, when an electrical device was first employed for firing guns. Pile batteries were used, consisting of about 160 elements of alternate copper and zinc plates separated by fearnought (a kind of flannel) dipped in a mixture of vinegar, salt and water. This was a high-tension circuit, and, owing to various troubles ,was soon replaced by a low-tension circuit employing Leclanché cells in series-parallel grouping, six cells being in series. Complete wire circuits were fitted from 1874 to 1881, when an earth return was used. The earth return has been retained for gun-firing circuits to this day.

In 1879, the discharge of torpedoes was effected from an observing and directing station remote from the torpedo itself, an electrical device being fitted for the first time.

The searchlight was the next electrical device to establish itself on board ship. From 1874, experiments had been proceeding, notably those carried out at Portsmouth by Mr. H. Wilde, F.R.S., of Manchester, on board the gunboat "Comet." In that year the Admiralty Torpedo Committee, reporting on "Wilde's Electric Light," made the following statement, which is very interesting, considering that it is dated more than half a century ago :—

> "When used in combination with the dioptric projector, it throws a strong beam of light to the distance of rather more than a mile, by means of which an object of the size of a launch, if of light colour, can be readily distinguished, and a similar object, if of a dark colour, at a distance of about three-quarters of a mile."

These experiments culminated in a complete searchlight installation being fitted in 1876 in H.M.S. "Minotaur." A Wilde alternator was used, the field being produced by 32 fixed electromagnets arranged axially round a flywheel type of rotor carrying 16 double coils. Part of the rotor circuit was connected to a commutator for supplying current to the field windings. The generator was belt-driven at 400 r.p.m. from an auxiliary pumping engine. The searchlight also was of very crude design. The carbons were square in section, fixed vereically, and adjusted by hand-operated mechanism. The beam was obtained by means of a dioptic lens and a hemispherical reflector.

Considerable development in searchlight design took place during the next three years, and in 1879 a comprehensive series of experiments was carried out by the Royal Engineers at Chatham to determine the most suitable searchlight equipment for military purposes. The Admiralty provided certain apparatus for inclusion in the trials, the results of which demonstrated the great advantages of an inclined hand-operated lamp and Mangin projector, the Mangin mirror displacing the dioptric lens.

H.M.S. "Inflexible" was fitted with the new type searchlights, the supply being taken from a direct-current Gramme machine. It was in this ship that in 1881 the first electric lighting installation was fitted. Both arc and incandescent lamps were used, the supply being taken from Brush dynamos at 800 volts. The Swan incandescent lamps were arranged in series-parallel grouping, with 18 lamps in series. A similar grouping system was adopted for the arc lamps. Every lamp had a substitutional resistance, which automatically took the place of the lamp when the latter failed. As one would now anticipate, such a system was not satisfactory, and eventually a much

lower voltage was adopted. In the early 'eighties, five Indian troopships were equipped with two Edison-Hopkinson type dynamos, the lighting pressure being 110 volts, and "Polyphemus" and "Colossus" were equipped with a lighting supply having a pressure of 80 volts. This latter pressure was then standardised, and electric lighting was adopted generally for warships. H.M.S. "Polyphemus" was the only warship in which an earth return for the lighting supply was used. The earth-return system in that ship was replaced later by a complete wire circuit, for reasons of reliability and safety.

A first-class ship of that period had three dynamos of 180-200 amperes at 80 volts. Under battle-action conditions one dynamo was capable of supplying the necessary lighting, leaving the other two dynamos for supplying the searchlights. The dynamos were independent of one another, although the switchboards were arranged to enable any one dynamo to supply, if necessary, any of the three groups of circuits.

The first cables used were rubber-insulated, with a serving of cotton tape or braiding, and coated with a preservative composition. The cables were run in teak casings and embedded in putty; but trouble was experienced owing to damp and heat. Lead-sheathed cables were then tried, the rubber insulation being replaced by four layers of jute yarns; but this also proved unsatisfactory, owing to the lead cracking and the jute deteriorating. Rubber-insulated cable with a lead covering was then given a trial. This was a great improvement and was adopted as the standard cable for ship wiring.

About the beginning of the present century the low pressure of 80 volts was increased to 100 volts, and electricity began to find increasing favour for power purposes as well as for lighting. The electric motor was gradually adopted for many uses in place of the steam engine. Power requirements soon made desirable a further increase in the pressure of supply, and, after much discussion, direct current at a pressure of 220 volts was adopted as a new standard for the larger British warships, the first ships using 220 volts being "Defence" (1905-8), and "Invincible" (1906-8). At that time the pressure of 220 volts was considered by several naval officers and eminent electrical engineers to be dangerously high for warship purposes, but the past 22 years' experience has demonstrated the fallacy of this view. "Defence" and "Invincible" were also the first ships in which a complete "ring main" system of distribution was employed, although parallel running of dynamos had already been used in ships built after 1904.

Probably the years 1904-6, with the adoption of 220 volts, the ring-main system, and parallel running of dynamos, may be taken as the beginning of modern electrical development in the British Navy. Since then, the applications of electricity have advanced in variety concurrently with those on shore; and the electrical installation of a warship to-day embraces most of the modern uses of electricity.

Whilst the purely engineering aspect of warship electrical installations is of intense interest, it is well to keep in view that the supreme consideration overshadowing all others, and the criterion by which success or failure must be judged, is their influence on the ultimate fighting capacity of the ship.

Conclusion.

A little thought will make clear the great changes which electricity has wrought in naval practice even within the lifetime of naval officers still on the active list. The development of wireless telegraphy and telephony would enable a Navy Board to keep in touch with fleets dispersed throughout the world. The commander-in-chief of a fleet uses electrical appliances for the handling of that fleet; the captain, in carrying out the various tactics; the navigation officer, in navigating the ship; the gunnery officer, in reaching the target; the torpedo officer, in operating torpedoes and mines and in protecting the ship from submarine attack; the engineer officer, in ensuring the mobility of the vessel and carrying on the manifold internal services; the medical officer, in treating the personnel. Thus electricity is not only an invaluable adjunct but has become an integral part of a fighting fleet's structure.

It is hoped that this rapid survey of the applications of electricity to naval vessels has not been without interest and value.

It is recognised that the greatest progress is made by a proper understanding of when and how co-operation with research and other workers should be effected, and by a vigorous development of experimental work. On the other hand, in the selection of the most suitable equipment for warship work, caution is necessary; electrical machinery and apparatus installed in warships must be

beyond the experimental stage. Any serious defect which may develop in machinery or apparatus in connection with public electric supply may result in costly inconvenience—admittedly serious—but a defect arising at a critical period in action in machines or apparatus fitted in large numbers in vital parts of a warship's installation may cause a consequential damage to the community which may have very far-reaching effects.

A full discussion is invited; any suggestions which may be made will receive close consideration. The author again emphasises the difficulties imposed by limitation of space and weight, sea conditions, extremes of heat and cold, the claims of other services in the ship, and the difficulty of fitting in one requirement with another. So far as the British Navy is concerned, all these conditions are reflected in the detailed requirements of the Admiralty specifications.

It is desired to place on record the willingness with which manufacturers in this country have co-operated in matters of investigation and development when invited to do so, and it is encouraging to know that much of the effort to meet naval conditions is not without its benefit to the electrical industry and is often reflected in commercial practice.

Finally, the author desires to thank the Board of Admiralty for having given him permission to present this paper to the Institution.

BRITISH AND AMERICAN PRACTICE IN THE WORKING OF HOT AND COLD METALS.

By F. W. Spencer.
(Of the Birmingham Small Arms Co., Ltd.)
(*Before the Royal Society of Arts, January* 6, 1927.)

The first historical reference to the working of Metals is from the time of Tubal Cain—so that in the thousands of years intervening from then until the present time, there has naturally grown up a practice which, to say the least, has become well established. It does not necessarily follow that because of its age alone it has reached a stage in its development that further advance is not possible; in fact, there is every indication that we are only just beginning to make use of the machines and the skill of the machine tool designers, which is and has been available for many years.

This slow development, like many other things, has been more pronounced in the older countries, although in looking through patent records one finds many inventions which have been taken out in this country, but apparently have either not been worked at all, or to any serious extent, and in consequence have been allowed to lapse, whereas in other countries these old patents have been worked, improved upon, and are to-day being used to great advantage in the production of so many of the parts of every-day mechanism with which everyone is familiar.

This rather dismal view I have put forward of what I think represents our past attitude, is slowly changing, and the competition we meet is making everyone concerned take stock of their methods, and consider in what way more articles can be produced with less expenditure on labour and material than before.

Although the title of this paper is a comprehensive one, I propose to confine my remarks more particularly to the makings of forgings in steel and other metals.

The inherent disadvantages of making articles in metal by melting the metal and pouring it into moulds of the required shape are well known, and in order to overcome these the steel to be used for making forgings after being cast into ingots, is rolled into bars or billets, this rolling and squeezing working out the impurities and producing a metal, which, as far as internal structure and physical strength is concerned, is greatly improved.

From these bars or billets practically all the important highly stressed parts of the modern motor car, aeroplane or motor cycle are manufactured.

The early methods of manufacture were to heat the steel to a temperature at which it became plastic, and for a blacksmith to shape the piece by blows of a hammer while supported on an anvil.

If that was the only method in use to-day, we should not see a fraction of the motor transport that we have come to regard as essential to our welfare.

Between 20 and 30 years ago the drop hammer was introduced to produce forgings in dies which had previously been made on the anvil by a smith.

The drop hammer consists of a tup or hammer working in between vertical guide rods capable of being raised and dropped by gravity at the rate of 60 or more times per minute on to a heavy anvil block. To the underface of the hammer is fixed a hardened

steel die block, on the lower face of which has been cut a half impression of the shape of the article to be forged, while another die block containing the other half impression with its face uppermost is firmly fixed to the anvil block. On the lower die block is placed a red hot bar of steel of suitable size, and the hammer is allowed to give repeated blows until the metal has been forced into and filled the impressions to overflowing, the surplus metal, termed flash, being subsequently trimmed from the forging by shearin gtools in a trimming press.

The rate of production of forgings by this method is from ten to one hundred per cent. greater than the rate at which they had previously been done by hand. Another feature was that they were all of uniform shape and size, which is not always the case when they are done by hand.

Good as these early drop forgings were, they do not compare with the modern drop forgings, and for this reason. The old method was to use a sufficiently large bar of steel to cover the impression in the die, no consideration being given to the direction of the fibre of the metal being in its most suitable position in the article to resist the strains which come upon it when in service. The aim of the present day drop forges is to so distribute the metal in forging that the maximum strength of the steel is realised when the article is in use. To do this entails a number of preliminary operations in various shaped tools on the bar before placing it in the dies for forging.

The drop hammer described is operated either by a hand lever or pulling cord, depending on whether steam or air or an electric motor drive is used to lift the hammer, so that the hammer gang consists of at least two men. This type of hammer is in use in practically every drop forging works in this country.

There are in use in America two types of drop hammers, one operated by steam and one driven by belt from line shafting. The first type is similar to the ordinary steam hammer, except that the stroke is longer and the guide rods are firmly fixed to the anvil block and support the overhead steam cylinder. The second type are called board hammers, in which case the tup is raised by means of rollers gripping a board to which the tup is fixed. Both of these hammers are self-contained units, and because of this are a great advantage in allowing any subsidiary plant such as trimming presses or furnaces to be placed in the most convenient position for the operators.

GEOLOGICAL SOCIETY.

The following papers were read at the meeting held on March 9, Dr. F. A. Bather, M.A., F.R.S., President, in the chair :—

The Geology of Maiao (Society Islands). By Lawrence John Chubb, M.Sc., and Walter Campbell Smith, M.C., M.A., Sec.G.S.

Maiao, or Tubai Manu, which lies some 50 miles west of Tahiti, consists of a small volcanic island about a mile long and 800 feet high, encircled by a barrier-reef 6 miles in diameter.

The volcanic rocks collected from the central island include a basalt with numerous phenocrysts of olivine and augite, of the type known to be abundant in Tahiti and the Austral Islands, a phonolitoid nepheline-tephrite, and an olivine-bearing basaltoid nepheline-tephrite somewhat similar to those described from Rurutu.

The Silurian Inlier of Woolhope. By Charles Irving Gardiner, M.A., F.G.S.; with Palæontological Notes by Frederick Richard Cowper Reed, M.A., Sc.D., F.G.S.

The beds seen in the inlier are those between the Llandovery and the Downtonian.

The coarse conglomeratic Llandovery Beds of May Hill are not exposed in the Woolhope district. The lowest beds seen are fine yellow sandstones containing a fauna like those of the similar sandstones at May Hill, and yielding *Stropheodonta compressa.* Above them come soft earthy shales.

The Woolhope Limestone is about 360 feet thick, but the most fossiliferous part of it is not now exposed; the Wenlock Shales are much thicker than they are at May Hill, but are seldom exposed.

The Wenlock Limestone shows a normal development.

The Lower Ludlow Beds have no counterpart at May Hill; they are sandy shales and mudstones, and very fossiliferous. The graptolitic zones of *Monograptus tumescens* and *M. scanius* have been recognised.

The Aymestry Limestone forms an important physical feature of the area. The Upper Ludlow Beds are normal sandstones.

The uppermost beds frequently show a slightly eroded surface. and on this rests a conglomerate of clay-pebbles or limestone-fragments full of fish-remains, forming the base of the Downtonian.

Higher up come false-bedded sandstones and shales, and the highest beds seen are red sandstones yielding *Lingula cornea.*

The inlier has been affected by pressures

in two directions. One from the south-west has markedly affected the southern portion of the inlier, at places bringing Downtonian deposits into contact with the Wenlock Limestone. The main result of this pressure was the bending of the Silurian rocks into an anticline, which, however, was crossed by faults running south-west and north-east, one of which passes from Mordiford to Tarrington.

Pressure also produced an anticline, the axis of which runs north-north-east and south-south-west.

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology was held in the University, Edmund Street, Birmingham, on Wednesday, March 16, 1927. Mr. Herbert Webb in the chair. Two papers were presented :—

Some Further Developments in Recuperative Glass Furnaces. By TH. TEISEN, C.E.

A new design of recuperator was described in which there was an increase in efficiency for two reasons :—(1) The greater heating surface ensured a higher temperature of the secondary air; (2) The reduction in space resulted in smaller radiation and convection losses. The recuperator comprised a main tube of special design combining the features essential for efficiency, and certain auxiliary shapes which together with the tube were required for building up a unit.

With the development of the recuperative furnace there had been a demand for a large unit. When built on the 2-recuperator principle the design outlined had certain drawbacks, to overcome which a new design was developed on what the author called his " Tetra " recuperative principle. This design had 4 recuperators instead of 2, arranged symmetrically in each corner of the base, and, for large furnaces, afforded the following advantages compared with the 2-recuperator principle :—

(1) Short length of recuperator enabling it to be cleaned or repaired from the front in its full length; (2) More efficient waste heat recovery; (3) In case of repair or cleaning, one recuperator could be shut off altogether and the furnace kept going with the remaining three; (4) The waste gas collecting flues and the glass pits could be arranged (nearly) symmetrically in relation to each other. For very large types, provision had been made to divide the side pockets into two ,so as to make each recuperator of a pair absolutely independent of each other. The author also described a simple application of a patent system of oil firing. All new pot furnaces were designed with a view to being fired on this system in case of emergency, as it entailed only slight modification of the design of the pocket. Furnaces working on this system could be fired either with oil alone, or with coal or producer gas in the ordinary way, combined with oil as auxiliary fuel.

The Properties of Some Soda-Lead Oxide Glasses. By VIOLET DIMBLEBY, M.Sc., S. ENGLISH, D.Sc., PROF. W. E. S. TURNER, AND F. WINKS, M.Sc.Tech.

Professor Turner, in presenting this paper, observed that although potash was more often used than soda in these glasses, nevertheless, the properties of one kind had a bearing on the properties of the other. The investigations made were systematic, and aimed at the determination of the effect which was produced by increasing progressively the proportion of lead oxide at the expense of the soda. In this way it was found that successive replacemnet of soda by lead oxide gave glasses with progressively decreasing annealing temperature and thermal expansion. Comparison was also made with glasses containing barium oxide, which were of much commercial interest. The action of boiling water on the glasses was investigated and the percentage loss in weight determined. It was found that lead oxide glasses were better than those containing lime, while those containing barium oxide were the worst of the series. A new set of factors was determined by which the thermal expansion of lead oxide and barium oxide glasses could be calculated. The new data were valuable for reference purposes on the scientific side, as well as for industrial practice. The factors originally proposed by Winkelmann and Schott in 1895 had been found to need revision, and the following were the new values : SiO_2 0.15; ZnO 0.21; Al_2O_3 0.52; ZrO_2 0.69; MgO 1.35; PbO 3.18; CaO 4.89; BaO 5.2; Na_2O 12.69; K_2O 11.7.

The reading of the third paper on the agenda was postponed, namely, " The Thermal Expansion of Some Boric Oxide Containing Glasses." By Prof. W. E. S. Turner, and F. Winks, M.Sc., Tech.

DEATH OF DR. F. B. POWER, Ph.D., LL.D.

Dr. Frederick Belding Power, Ph.D., LL.D., who died of heart failure on March 30th at Washington, D.C., U.S.A., will best be remembered by British pharmacists as Director of the Wellcome Chemical Research Laboratories, a position he held from the founding of the institution in 1896 until 1914.

By early training a pharmacist, Dr. Power retained his interest in pharmacy throughout his life work in England, Germany and America, and his death removes a figure of international influence in pharmaceutical and chemical research.

Born on March 4, 1853, at Hudson, New York, Dr. Power commenced his association with pharmacy at an early age. Five years later he was working as a practical pharmacist in Chicago. From Chicago he moved to Philadelphia, and was connected with the business of the late Professor Edward Parrish, a notable pharmacist and lecturer of those days, whose name is linked inseparably with the compound syrup of phosphates, commonly known as Parrish's Food. In 1874 he graduated in pharmacy at Philadelphia, and was awarded the prize in chemistry. In 1876 we find him in residence at the University of Strasburg, where he took his degree in 1880 after acting as assistant to the famous Professor Flueckiger during 1879.

Returning to America in 1881 he became Professor of Analytical Chemistry at the Philadelphia College of Pharmacy. Two years later he was called upon to establish the school of pharmacy at the University of Wisconsin, where he occupied the chair of Pharmaceutical Chemistry and Materia Medica.

In 1896, at the invitation of Mr. Henry S. Wellcome, Dr. Power came to England as director of the Wellcome Chemical Research Laboratories. In this way the close personal friendship dating from boyhood was renewed. Mr. Wellcome and Dr. Power were class-mates at the Philadelphia College of Pharmacy, at which time neither could have foreseen that they would later be associated in research work for years.

Under his direction no less than one hundred and sixty-eight scientific papers from the Wellcome Chemical Research Laboratories were communicated to learned societies, and during this period Dr. Power gained a wide reputation as a research chemist particularly in the field of plant chemistry, which he made peculiarly his own.

One of his most important researches was his investigation of the constituents of chaulmoogra and hydnocarpus seeds which ultimately formed the foundation on which has been built up the modern treatment of leprosy.

In 1914 Dr. Power returned to America where he was appointed Director of the Phytochemical Laboratory of the Bureau of Chemistry at Washington, D.C., a post he held until his death.

Dr. Power's scientific work made him the recipient of many honours. In 1908 the University of Wisconsin conferred upon him the honorary degree of Doctor of Laws, and in 1913 he was awarded the Hanbury Gold Medal. In appreciation of this honour he was presented by his colleagues and associates with an illuminated address. In 1921 Mr. Wellcome, Founder of the research institution bearing his name, presented Dr. Power with a gold medal bearing the doctor's profile portrait in relief and commemorative of his distinguished services to science. Dr. Power was an honorary member of many scientific societies and institutions, and in America he was recognised as one of the leading pharmacognosists. He was a Fellow of the Chemical Society of London and a Member of the corresponding societies in America and Berlin; corresponding Member of the Royal Society of Pharmacy of Brussels; Honorary Member of the Philadelphia College of Pharmacy; Vice-President of the Society of Chemical Industry, 1904-6, and he served on the Council and Publications Committee of this Society. He was awarded the Ebert Prize in 1877, 1892 and 1920.

Dr. Power served on the Committee of the United States Pharmacopœia and in 1920 was elected Vice-President of the United States Convention. One of the last honours that was bestowed on him was his appointment, by the President of the United States as a member of the National Research Council on the Committee of Federal Relations.

ROYAL INSTITUTION.

At a general meeting of the Members of the Royal Institution held on April 4, Sir Arthur Keith, Treasurer and Vice-President, in the chair, Mr. G. B. Ellis, Lady Fox, Miss M. D. Gann, Mr. Walter Heath, Sir Frederick Hopkinson, Mr. T. W. Mellor, Mr. Archibald Page, Mrs. Somerset, Sir Josiah Stamp, and Mr. Arthur Wright, were elected Members.

NOTICES OF BOOKS.

Descriptive Bibliography on Oil and Fluid Flow and Heat Transfer in Pipes. Technical Series Bulletin, Missouri School of Mines, Rolla, Mo. By JOE B. BUTLER, Associate Professor of Civil Engineering.

This bulletin of 62 pages lists and describes 370 references to published articles and books. The references are arranged chronologically as to year of publication, are fully cross-referenced, and are indexed as to subject, author, and periodical. A short article on the flow of oil in pipes gives formulæ, data and procedure in solving problems.

All articles with data on friction loss and heat transfer in oil flow are included. Of the articles on flow and heat transfer in pipes of water, air, steam and gases, only those with data pertaining to fluids in general are listed. Articles on critical velocity, viscosity and viscosimetry are included if they have applications to oil or fluid flow in pipes.

In 1914, Stanton and Pannell experimentally established for fluid flow in pipes that the friction factor in the ordinary hydraulic formulæ is a function of the ratio of the inside diameter of the pipe times the average velocity of flow times the specific gravity of the fluid divided by the absolute viscosity of the fluid. Curves showing this relation over both the streamline and turbulent regimes of flow are plotted from experimental data on water, air oil and steam. The author lists 51 references having data or curves applicable to oil over both regimes of flow.

Copies of this bulletin may be obtained by writing to the Librarian of the Missouri School of Mines, or to the author.

FORTHCOMING EVENTS.

THE ROYAL INSTITUTION.

Albemarle Street, London, W.1.

Saturday, April 9, at 3 p.m.—Sir Ernest Rutherford: "The Alpha Rays and Atomic Structures."

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Wireless Section.—Monday, April 11, at 6 p.m.—"The Maintenance of Small Electric Power Plants." Opened by Mr. T. Hodge.

North-Eastern Centre.—Monday, April 11, at 7 p.m.—Lecture on "The Applications of Electricity to Agriculture." (To be illustrated by a cinematograph film.) At the Literary and Philosophical Society, Westgate Road, Newcastle-on-Tyne.

Western Centre.—Monday, April 11, at 7 p.m.—"The Design of City Distribution Systems, and the Problem of Standardisation." By J. R. Beard, M.Sc., and T. G. N. Haldane, B.A. (At the South Wales Institute of Engineers, Cardiff.)

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

7,595.—Du Pont de Nemours & Co., E. I. —Disinfectants. March 18th.

7,062.—I. G. Farbenindustrie Akt.-Ges. —Production of derivatives of N-dihydro-1.2.1^1.2^1. anthraquinone fast to chlorine. March 18th.

7,061.—I. G. Farbenindustrie Akt.-Ges. —Production of aldehydes. March 14th.

7,563.—I. G. Farbenindustrie Akt.-Ges. —Production of fast yellow dyeings, etc. March 18th.

Specifications Published.

267,177.—Soc. of Chemical Industry in Basle.—Manufacture of vat dyestuffs and intermediate products therefor.

267,191.—Waring, H., and Associated Lead Manufacturers, Ltd.—Manufacture of oxide of lead.

244,134.—Cederberg, Dr. I. W. — Apparatus for the catalytic combustion of mixtures consisting of ammonia and oxygen.

267,246.—I. G. Farbenindustrie Akt.-Ges. —Recovery of sulphur.

267,457.—Farbenfabriken vorm F. Bayer & Co.—Manufacture of new quinoline derivatives.

Abstract Published.

264,804.—Synthetic drugs. — Hoffman-la Roche & Co., Akt.-Ges., F., 184, Grenzacher Street, Basle, Switzerland.

Ureides of dialkyl- or arylalkyl-acetic acids are prepared by heating dialkyl- or arylalkylbarbituric acids with dilute alkali solutions. The products possess hypnotic properties. According to the examples : (1) the ureide of allylisopropylacetic acid is obtained by heating allylisopropylbarbituric acid with dilute aqueous solutions of ammonia, ammonium carbonate, or sodium hydroxide to which sodium and potassium phosphates may be added, or with lime water saturated with carbon dioxide; (2) diallylacetylurea results when diallybarbituric acid is boiled with weak aqueous ammonia; (3) phenylethylacetylurea is obtained by long heating of phenylethylbarbituric acid in slightly ammoniacal solution.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

AVIROL.

476,298.—Chemical substances in Class 1, for use in the dyeing industry.—H. Th. Bohme, Aktiengesellschaft 29, Moritzstrasse, Chemnitz, Germany. March 23rd.

FROTHBLOWER.

477,173.—Chemical substances prepared for use in medicine and pharmacy.—Herbert Temple, 145, Cheapside, London, E.C.2. March 23rd.

IZALMINT.

477,770.—Chemical substances prepared for use in medicine and pharmacy.—Newton Chambers & Company, Limited, Thorncliffe Ironworks and Collieries, near Sheffield. March 23rd.

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MILLER'S EXPERIMENTS AND THE CONSTITUTION OF MATTER. II.

By W. TOMBROCK (Holland).

Time is measured duration. Measured duration is unambiguous; hence time is called absolute. The ideal time measure is invariable and unambiguous. An actual time measure is practically never so. The actual time measure is dependent on circumstances; the actual time measure is therefore relative. But, although the actual time measure is relative, the time, the measured duration, is not therefore relative. Time is expressed : a number × the unit (numerus et mensura motus . If the interval between two given instants, a given passage of time therefore, is measured with a smaller unit, then the number becomes greater, the product recalculated in the ideal time unit remaining constant. In this lies the absoluteness, the unambiguity of time. Whoever calls time relative confuses time with time measure or unit, in other words, confuses time with motion.

Matter is the substratum of all physics. It is besides that which moves. Ether is therefore also matter.

Energy is the potentiality of matter. Energy is thus according to accepted, acknowledged definition something different from matter by itself. Energy is something of a different order. It is therefore nonsense to say " Energy can be converted into matter and *vice versa.*" Water cannot be converted into gravitation, heat, light, and so on. Heat, light, etc., are states (of motion) of matter; water is matter in a definite state of motion (a fairly stable configuration of motion) . . . a great difference. Ether will be as a gas of which, however the molecules are the ultimate material particles. On the contrary, it is certainly not illogical to suppose that ether could be converted (could change) into matter perceptible to the senses and *vice versa.*

If matter is the substratum of all physics and if two material bodies (particles) cannot occupy the same place at the same time then the ether must be divisible, and secondly, there must be a vacuum outside the ultimate material particles; otherwise no motion would be possible.

PROPOSITIONS.

1. The principle of relativity is in contradiction with the principle of the constant velocity of light. The special relativity of time serves to mask this disagreement. (Tummers : " Die spezielle Relativitätstheorie Einsteins und die -Logik." " La Relativité restreinte d'Einstein et la Logique." Obtainable from Dr. J. H. Tummers, Hoogeweg, Venlo, Holland.)

2. Time is measured duration and as such is absolute . The time measure or unit is dependent on motion and as such is relative. The special relativity of time rests upon a confusion of time with the time unit, in other words, on a confusion of time with motion.

3. In explaining light phenomena one has to take into account

(a) a possible gaseous structure of the ether,

(b) that which happens by the direct action of matter observable by the

senses on ether, that which thus happens to the ether within the atomic sphere of action,

(c) electron emission (emission *and* undulation).

4. In connection with 3 (b) and (c) and in explaining the result obtained by Miller one should take into account that the direct action of matter perceptible to the senses (reflecting mirrors) on the emitted electrons can be different when the mirror is perpendicular to or parallel with the motion through the ether. It appears possible that the duration of the reflection would then be different and that this phenomenon is detectable in the given experimental circumstances only when high velocities are reached (more than 200 kms. per sec.).

5. Light is not to be considered as an emission (particles sent out) *or* an undulation (waves in the otherwise stationary ether), but as an emission *and* an undulation.

It will depend on experimental circumstances whether the light will present itself to us as emission or undulation.

In the Michelson-Morley-Miller experiment the light presents itself first as an undulation for a velocity of the experimental apparatus greater than 200 kms. per sec. and then only as a much weakened effect (10 kms. per sec.).

6. In light phenomena not only electron emission but also electron transmission plays a part. That is to say that ordinary more or less gaseous ether particles can be transformed b ythe atomic action of the light source into electrons and emitted.

The following list of references may be given though without any pretension to completeness.

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THE HONEY-BEE AND THE FRUIT GROWER.—HOW THE FLOWERS ARE FERTILISED.

By A. E. Lundie, B.Sc., M.A., Ph.D.

[Note.—The importance of the fruit crop can be scarcely over-valued, whether regarded from a financial or health point of view. Fertilisation is of primary importance in the fruit-growing industry, but fertilisation is of little use if the crop be ruined by insect and other pests. The fruit-grower everywhere has to contend with various difficulties, one of the greatest being the insect pest, which takes such a heavy toll of the results of his labour, despite his most assiduous efforts to successfully combat them. Science is playing a predominant part in the warfare against insect and other pests, by placing effective weapons in the hands of the fruit grower.

The Government of the Union of South Africa is specially helpful to the fruit grower and farmer generally by the various scientific departments which have schools, branches and representatives throughout the Union. Were it not for this laudable and active solicitude, the fruit crop of the Union would not have attained the prominence and importance which it has now reached.

The fruit grower in Great Britain has also to fight various pests, one of the most destructive of which is the codling moth, compared with which the American blight is a comparative harmless enemy, whose presence is manifest, which can be kept under control without very much effort, and whose injury to the crop is of the indirect kind. There is no circumlocution about the attacks of the codling moth; it attacks not the tree but the fruit, is a very elusive enemy whose habitat it is virtually impossible to locate, until the damage is done to a great part of the year's crop.

The attached article, informative and interesting, which deals with the fertilisation of flowers and fruit trees, by Dr. A. E. Lundie, will, we are sure, be read by all specially interested in fruit growing, either in a large way for profit, or in a small way

for both pleasure and profit. There can scarcely be a reader who will not read with interest Dr. Lundie's article, with its clear exposition of how blossoms are fertilised, and the important part played by the honey-bee in the matter.

The value of the article is greatly enhanced by the illustrations attached. While the writer singles out the blossoms of the pear tree for attention, his article applies in a general sense to various other kinds of blossoms.—ED., CHEM. NEWS.]

What fruit grower—be he the owner of but a fruit tree or two, or one risking great hazards with trees numbering thousands—has not watched with interest the swelling of the buds in spring and the opening of the beautiful blossoms, heralded as it is by the music of hundreds of bees and other insects eager to secure their loads of nectar and pollen?

Here, in what appears to be the simple act of a number of insects flying from one source of food to another, we have an extraordinary example of that interdependence of Nature's species in which is involved the very existence of many plants and animals, not excluding man himself.

STRUCTURE OF A FLOWER.

To get a better appreciation of this interesting problem, let us examine a flower, that of a pear, for example, as depicted in

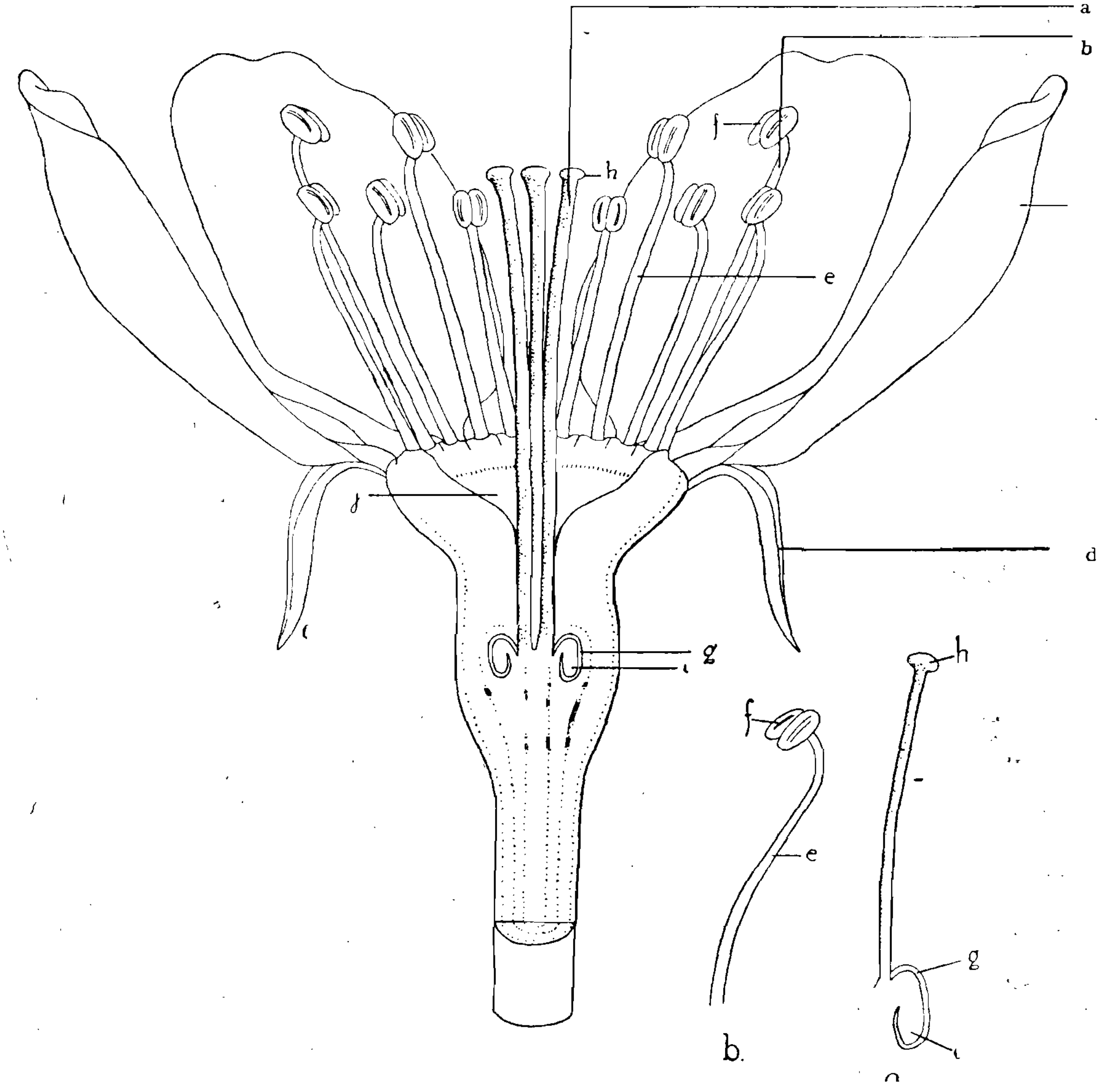

Fig. I. This will be seen to be built up of four different groups of structures arranged in circles of whorls.

The two inner circles are made up of the *pistils* (*a*) and *stamens* (*b*), the parts bearing the essential sex cells of the plant. The two outer circles are made up of the *petals* (*c*) and *sepals* (*d*); these are merely protective or attractive structures, since, in the developing bud, they shield the delicate sex organs inside and, in the open flower, they are commonly the chief contributors to its beauty and attractiveness.

Each stamen (*b*) consists of a stalk or *filament* (*e*), bearing an *anther* or pollen-sac (*f*), and within this sac a large number of *pollen* grains are produced. From the contents of each individual pollen grain two male sex cells ultimately develop.

Each pistil consists of a closed chamber, or *ovary* (*g*), at the top of which is a stalk bearing the club-shaped *stigma* (*h*), a structure so adapted as to catch and hold the pollen grains that fall upon it, borne thereto by wind, by insects, or by some other factor. The ovary contains the *ovules* or potential seeds (*i*), and each ovule contains a female sex cell.

Before an ovule can become a seed, the cell of the female sex must fuse or combine with a cell of the male sex.

Pollination is the term applied to the mechanical transference of the pollen grains from the anther or pollen-sac of the flower to the stigma and is a necessary antecedent to fertilisation.

How the Female Cell is Fertilised.

Many flowers when they are ready to be pollinated give out a sweet, highly scented fluid from certain glands known as *nectaries*, Fig I., (*j*). This liquid, or nectar, as it is called, is gathered by bees and converted into honey. The " bee-bread " or nitrogenous diet of the honey-bee is made from pollen grains; these the bees make into small pellets which they carry on their hind legs to the hive.

Fertilisation is the term applied to the fusion of the male sex cell with the female sex cell. Before this fusion can take place, however, the respective sex cells must be brought together in close proximity. After *the pollen grain has arrived upon the stigma* this is accomplished by the development of a remarkable tube from the pollen grain to the ovule as shown successively in Fig. II.

(1) A pistil or female organ of a flower ready to receive the pollen. This stage is always preceded by a re-arrangement of the female elements of the plant. (*a*) Stigma, (*b*) developing seed coats, (*c*) ovule, or potential seed, (*d*) ovary wall, (*e*) microphile or opening for the entrance of the pollen tube.

(2) Pollen grains on the stigma. The stigma has now been pollinated. (*f*) Pollen grains.

(3) The pollen grain (*g*) just beginning to send out a tube, the tip of which bears two male cells or nuclei.

(4) The pollen tube penetrating the tissue of the pistil on its way to the ovule.

(5) Farther growth of the pollen tube, which absorbs nourishment from the tissue through which it advances .

(6) The tip of the pollen tube has now reached the ovule or future seed. Here it enlarges very much and finally discharges the two male cells or nuclei. One nucleus (*h*) enters into the formation of the embryo or extremely minute plant and the other (*i*) into the formation of nutritive tissue which may be used up by the embryo during the ripening of the seed, as in peas and beans, or it may persist in the mature seed, being used up by the embryo during germination as in cereals.

As in animals, so with plants, in the fertilisation of the egg or ovule, the protoplasm or living matter of the two sexes is combined. This union is the only direct link between parents and offspring, and only across this exceedingly narrow bridge are characteristics transmitted by inheritance from one generation to another.

Duration of Pollination.

The time involved in the journey of the pollen tube from the stigma to the ovule may be anything from a few hours to as long as thirteen months in certain oaks.

Although several pollen tubes may penetrate the stigma, only one actually enters into the fertilisation or composition of a single seed.

The attraction which the female organs of the flower have for the developing pollen tube can be demonstrated experimentally by placing some pollen grains with a bit of *the stigma (ovule or ovary wall) of the same* plant. It will then be found that all the pollen tubes will turn toward the stigma, irrespective of the direction from which they first issue from the pollen grains.

After fertilisation has been accomplished, the stigma and the petal of most conspicuous flowers fall off. The stimulus of the sex

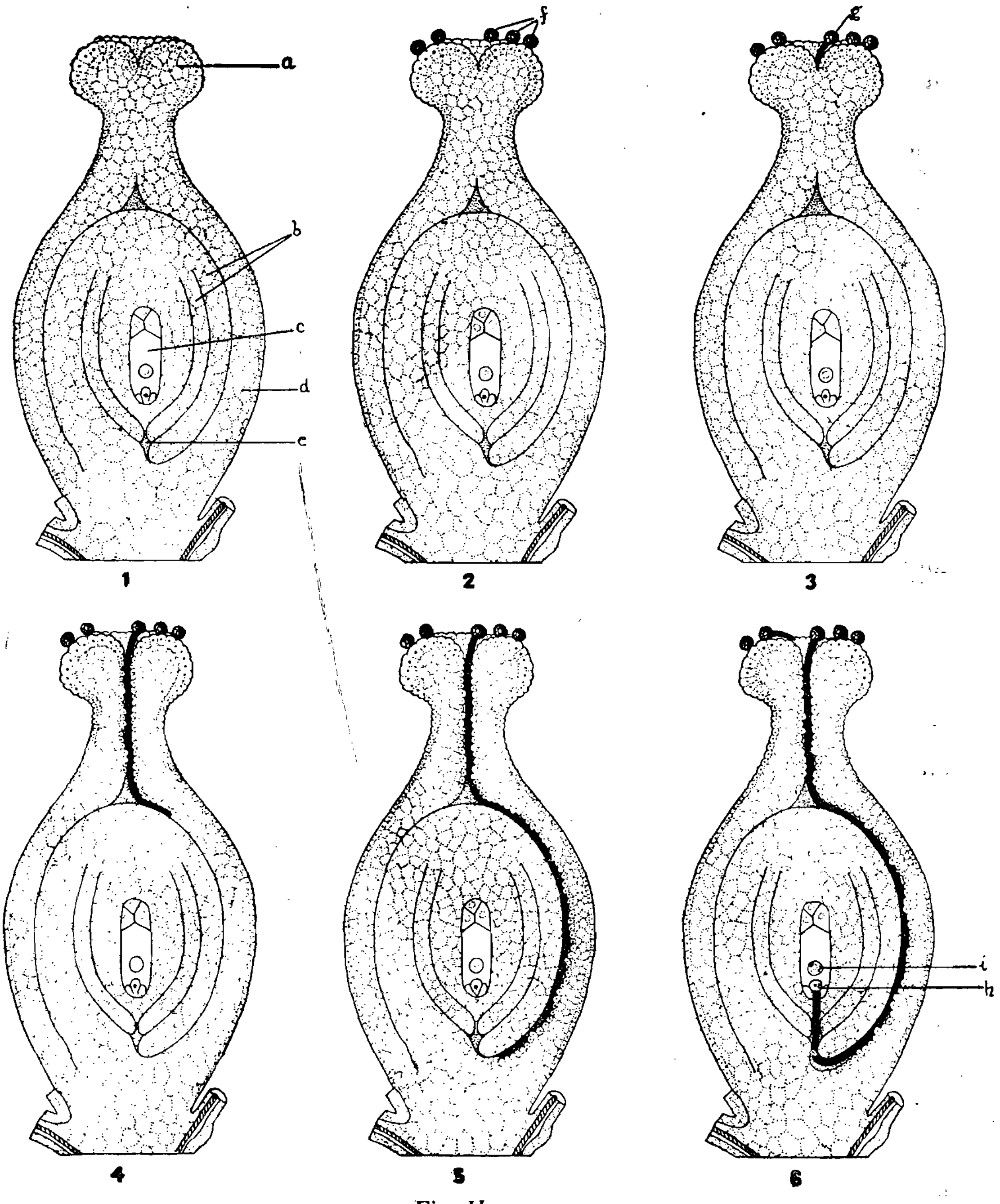

Fig. II.

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ual act incites the ovule to grow, and a similar influence is transmitted to the tissues of the ovary wall, which also grows and expands to allow for the development of the seeds. So is a flower converted to a fruit.

Cross and Self Fertilisation.

Fertilisation effected by the sex cells from the same plant is known as self-fertilisation; that by sex cells from different plants as cross fertilisation.

A great many devices are met with among flowering plants which serve to ensure a preponderance of cross fertilisation over self fertilisation. For example, the male and female organs may be born in separate flowers, or the pollen has no fertilising effect upon the female organs produced in the same flower.

A matter of considerable importance to the fruit grower is the fact that most of the common orchard varieties (see Table No. 1) will not set any fruit at all unless cross fertilisation with another variety has taken place. It has been found that even those varieties that set fruit when self fertilised will set a better crop when cross fertilised.

Table I.

Fruit.	Number of varieties tested.	Number of varieties found to be barren to their own pollen.
Pear	36	22
Apple ...	119	77
Cherries ...	32	32
Almonds ...	17	17
Plums ...	16	13

Some varieties, again, which usually are receptive to their own pollen may not be so under certain peculiar conditions.

The Honey-Bee and Pollination of Fruit Trees.

These facts serve to emphasise the importance of making provision for such eventualities, firstly, by planting compatible varieties (*i.e.*, varieties whose pollen is mutually receptive), and secondly, by ensuring that there will be insects in abundance to work the pollen when the trees are in bloom. This phase in the production of fruit is too often left to chance.

The majority of fruit trees depend upon insects for their pollination. Such plants have conspicuous flowers and a sticky pollen in contrast to the light powdery, dry pollen produced in greater profusion by the inconspicuous flowers that depend upon the wind for their pollination, such as maize. Experiments show that pollen from insect-pollinated flowers very rarely reaches the stigma through the agency of the wind.

Fruit trees blossom early in the spring, when most insects have not yet had time to rear sufficient young to replace the increased death-rate brought about by the winter. Honey-bees, however, on account of their social mode of life with reserves of food stored in the hive from the previous season, are able to rear several brood cycles, or generations of young bees, before the blossoms appear. In a year the progeny of a single queen bee may be over 200,000, there being seventeen cycles in most localities in South Africa. These facts all tend to make the honey-bee the most numerous insect in the orchard at the time of blossoming when other pollinising insects, on account of their non-social mode of existence, small egg-laying capacity, with perhaps only one or two brood cycles in the year, cannot be numerous enough to be of any great value to the orchardist.

The hairy body of the honey-bee, consisting of many branching hairs, and its habit of working many blossoms till a maximum load of pollen is secured, makes the honey-bee a very suitable vector for the pollen.

More Beehives in the Orchard.

The orchardist can also concentrate honey-bees in his orchard by distributing hives among the trees during the blossoming period; the handling of other pollinising insects in sufficient numbers is impracticable.

This extraordinarily adaptability of the honey-bee to bring about fertilisation, and the subsequent setting of the fruit in economic quantities, is worthy of more attention from South African fruit growers. The fact that some fruit growers spray with poisonous insecticides while the trees are in full bloom to the detriment of the bee population shows that they have not yet learned the true value of this insect to them.

Investigators of this problem consider that one hive to the acre will supply sufficient bees to bring about an efficient pollination of the blossoms. Whether the orchardist should own bees for pollination purposes, or whether he should remunerate a bee-keeper for his services in placing hives in sufficient numbers throughout the orchard during the blossoming period, are questions which depend upon circumstances.

Fortunately for the South African fruit growers, honey-bees will fly great distances in search of nectar and pollen (some 2 to 3 miles, depending upon the topography

of the country and the availability of nectar in the immediate neighbourhood), and the mild climate gives the non-social insects a better chance to survive the winter, so that fruit crops are often secured in spite of the lack of any special provision for pollination.

So-called wild swarms that have never been subjected to man's dominion occur in fair abundance in most localities, but on account of the adverse factors, such as cold, lack of food, floods, and predatory enemies, against which these swarms have to contend, they are usually deplorably weak at the time fruit trees are in bloom and can not always be depended upon to bring about an efficient pollination of the blossoms.

MORE BEES MEAN MORE FRUIT.

Overwhelming evidence has now been accumulated by various investigators working in different parts of the world, which shows that, other factors being at an optimum, increased crops are secured by having honey-bees in abundance in the orchard at the time of blossoming.

These few facts have been presented to remind the fruit grower that: (1) more bees mean more fruit; (2) any unnecessary mortality of such beneficial insects should be avoided, by not applying the first codling-moth spray until the bulk of the petals have dropped; and (3) provision for the prosperity of these insects, by suitable housing and intelligent care, are matters that directly concern him.

The honey-bee is more valuable to man on account of the work it does in pollinating plants—plants which yield the many million pounds worth of food upon which man is so dependent—than as a honey producer.

General Notes.

INTERNATIONAL COMBUSTION, LTD.

International Combustion, Ltd., have announced that they have been officially instructed to proceed with a repeat order from the Derby Corporation Electricity Department.

This order covers the supply of an additional 80,000 lb. boiler complete with drying equipment, " Lopulco " water-cooled combustion chamber, superheaters, economisers, draught equipment, dust catching apparatus and stacks.

This repeat order follows the successful outcome of a trial carried out by an independent consulting engineer for a period of 100 hours and 33 mins., under all conditions of load when it was officially established that the efficiencies obtained under these daily operating conditions, exceeded the guarantees, even when taking into consideration that the fuel used throughout the trial had an average calorific value of 9,930 B.T.U's.

Recently, when reading a paper before the Institution of Electrical Engineers (Derby Centre), Mr. Lake revealed that at an eight hour trial it had been established that 88.45 efficiency had been obtained.

During the trial conducted by the independent Consulting Engineer it was further established that the " Lopulco " operated boiler plant, when isolated on to a 10,000 kw. turbo generator, which throughout the trial had an average load of 3,300 kw., produced electrical energy at a consumption of 19,100 B.T.U's. per unit generated.

AGRICULTURAL AND SKILLED WORKERS LEAVING GREAT BRITAIN

The Board of Trade give particulars of the occupations recorded as followed by emigrants from and immigrants into Great Britain and Northern Ireland during last year. The net loss to the country in the agricultural group was 12,036 adults, or 26 per cent. of the total net loss, while skilled trades accounted for no less than 37 per cent.

INFLAMMABILITY OF COAL DUSTS.

A paper by A. L. Godbert, entitled " Laboratory Methods of Determining the Inflammability of Coal Dusts," has just been published. It contains an historical survey of the subject, a review of the influence of various factors on the inflammability of dust clouds, and a discussion of the relative inflammabilities of coal dusts. It indicates the lines of further researches now proceeding in the Board's laboratories at Sheffield, and should be regarded as preliminary to a full report on the results of those researches.

TO MINE CAPE BRETON GYPSUM.

Active preparations are under way for operation of the extensive Cheticamp, Cape Breton, gypsum quarries by Atlantic Gypsum Products Co., of Boston, Mass. In readiness for the opening of summer navigation, 300 feet of old trestle has been torn down and work is starting at once on a modern conveyor system between the plant and the old Fiset wharf which is being re-

paired for cargo vessels. A railway spur from the plant to the harbour is also being put into shape. Quarrying will begin early in April.

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Key Industries.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding the article, Urea.

Any person desiring to communicate with the Board of Trade with respect to the above-mentioned application should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within one month from April 6, 1927.

ROYAL SOCIETY RECEPTION.

On the evening of 6th inst., the President and Council of the Royal Society held a *conversazione* at Burlington House to meet the delegates to the Lister Centenary celebrations. Sir Ernest and Lady Rutherford received the guests, supported by Sir David and Lady Prain, Sir Richard Glazebrook, Dr. H. H. Dale (secretary), and a large number of Fellows of the Society.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

Applications for Licences in March, 1927.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during March, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 606, of which 479 were from merchants or importers. To there should be added 10 cases outstanding on the 28 February, making a total for the month of 616.

Of the total of 616 applications received 559, of 91 per cent. were dealt with within 7 days of receipt.

FOOT AND MOUTH DISEASE.

This disease, which causes such ravages among livestock, seems to successfully baffle the efforts of the chemist to find an effective antidote. On the Continent the losses must be great and widespread, judged by the number of outbreaks. Thus during 1926 the outbreaks were as follows :—

Great Britain	204
Belgium	35,519
France	48,959
Holland	62,656
Denmark	97,434
Germany	187,527

GYPSUM PRODUCTS IN CANADA.

Important construction work will be undertaken at Pinkney's Point near Yarmouth, N.S., by the Canadian Gypsum Company, according to an announcement made by Mr. Otis Wack. president of the company. Wharves and storage bine will be constructed and large areas prepared for storage of products of the company's quarries near Windsor, N.S. The work will be undertaken prior to April 1. The plans provide for an expenditure of $180,000 over a period of years and also cover the possibility of the erection of a refining plant.

THE CANADIAN WHEAT POOL.

Of the 226,000,000 acres of land sown to produce the 1926-7 wheat crop of the world, Canada sowed about 10 per cent. Last year Canada had a total wheat crop of over 406,000,000 bushels, of which 380,000,000 bushels was Spring wheat. Of this amount it is figured that there will be an exportable surplus of 309,000,000 bushels. of which 152,000,000 had already been exported by the middle of February. This left a total of nearly 158,000,000 bushels to be exported. About 90 per cent. of the wheat crop of Canada is grown in the three Prairie Provinces — Manitoba, Saskatchewan and Alberta.

About 65 per cent. of the wheat crop of Western Canada is sold by the Canadian Weat Pool, a farmers' co-operative organisation, the largest of its kind in the world. The Wheat Pool Movement was first organised in Alberta in 1923. The following year pools were formed in Saskatchewan and Manitoba. The Alberta pool now has a membership of 38,000. The Saskatchewan pool has a membership of over 80,000, and the Manitoba pool has 19,000 members. The total membership of the three pools is, therefore, over 137,000.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

At the meeting held on Thursday, March 17, the following papers were read :—

The Structure of Certain Silicates. By W. L. BRAGG, F.R.S., AND J. WEST.

The present paper discusses the structure of certain simple types of natural silicates and related compounds. In particular, the predominant effect of the oxygen atoms in determing the form of the structure is investigated. In a number of compounds the oxygen atoms prove to be arranged in one of the forms of closest packing, the atoms of metal or silicon being inserted into this oxygen assemblage and causing only a slight distortion of its ideal arrangement. Typical examples are the compounds Al_2O_3, $BeAl_2O_4$, $MgAl_2O_4$, Mg_2SiO_4, $MgCaSiO_4$, $(MgOH)_2Mg_3\ (SiO_4)_2$, Al_2SiO_5 (Kaynite). The metal and silicon atoms form a complex pattern woven upon the simple oxygen arrangement. In the diffraction of X-rays by these crystals, which are often characterised by low symmetry and large unit cell, the simple pattern produced by the oxygen arrangement is evident, superimposed upon the pattern produced by the crystal as a whole. Other silicates are based upon more complicated arrangements of oxygen atoms, but these atoms appear in all cases to play a highly important part in determining the structure.

The Analysis of Beams of Moving Charged Particles by a Magnetic Field.. By W. A. WOOSTER. Communicated by Sir Ernest Rutherford, P.R.S.

1. The intensity distribution in the line produced by a magnetic field acting on a beam of homogeneous particles is determined
   (*a*) for a source of particles which is infinitely narrow;
   (*b*) for sources of various finite widths.
2. The conditions under which the analysis of moving charged particles is most favourably carried out are derived from this structure of the lines.
3. The application of this analytical method to the determination of the velocity distribution of particles passing through thin sheets of matter is pointed out.

The Magnetic Susceptibility of Some Binary Alloys. By J. F. SPENCER AND E. M. JOHN. Communicated by W. Wilson, F.R.S.

The magnetic susceptibility of the pure metals gold, silver, lead, tin, bismuth, aluminium, and cadmium, and a complete series of binary alloys of lead with gold, silver and tin; tin with aluminium, bismuth, gold and cadmium; and gold with cadmium have been measured by means of a Curie balance. The susceptibility-composition curves indicate the existence of some intermetallic compounds which have not previously been recognised, for example, Al_4Sn_3, Ag_9Pb_2 and Sn_4Bi_3; they confirm the existence of other compounds, for example Pb_3Au_2 $AuSn_2$ $AuCd_3$; but fail to confirm the existence of other known compounds. The curves and measurements show that the alloy of lead and silver containing 20 per cent. of lead is comparatively strongly paramagnetic, that of lead and gold containing 94 per cent. lead is strongly diamagnetic, and the aluminium-tin alloy containing 75 per cent. of tion is also strongly diamagnetic. The susceptibilities of the lead-tin alloys, where compounds are not formed, may be calculated by the mixture rule.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The following paper was read at the meeting held at the Royal Society of Arts on March 8 :—

Two Shallow Oilfields in Texas A Detailed Study. By ARTHUR WADE, D.Sc., A.R.C.Sc., F.G.S., M.Inst.M.M., M.Inst. P.T., F.Am.G.S.

INTRODUCTION.

The fact that the United States of America produces more than three times as much oil as does the rest of the world gives rise to peculiar conditions which are, I am sure, sometimes not appreciated by outsiders.

The great variety of conditions under which petroleum occurs, the widely distributed oilfield areas in one limited geographical region, the vast number of operators and operating concerns, the proximity of large centres of population with factories, workshops, supply houses and markets produce conditions of strenuous competition in forms which exist nowhere else. One result of this is that new methods are tried and old methods abandoned with greater readiness than elsewhere so that change and evolution are rapid in every branch of the oil business. Again, in consequence of some of the factors mentioned above greater opportunities arise for the small company

and the individual operator than in most oilfield areas. Land for drilling purposes can frequently be obtained on very easy terms, and for the expenditure of a few hundred dollars a well can be drilled, especially where oil sands exist at shallow depths. Very many shallow fields have been opened up in this manner, especially in the States of the Middle West and South, and many sands which have returned good profits on comparatively small capital expenditure have been developed at depths varying between 150 feet and 2,000 feet. The larger companies have in the past shown a tendency to ignore these shallow horizons, and I know of cases where drillers have been reprimanded for taking time to test and report them. The sequel in one such case was interesting. The driller waited for about twelve years, until the company had abandoned its wells from a deeper sand. Then in company with the local barber, baker and teamster, he acquired a portion of the area, put down a well which yielded 100 barrels of oil a day from a depth of about 500 feet and greatly improved the financial condition of the enterprising members of the little syndicate.

The independent oilfield geologist and technologist finds such conditions very favourable to his existence. Though there has been a tendency, which still exists, on the part of the small operators and companies to despise the work of the geologist and expert, a tendency which is due in part to the poor quality of some of them and to the fact that it has been easy for the charlatan to enter this field of work, the spread of knowledge and the successes won largely by the geologists of the major producing companies in discovering and opening up new fields is rapidly dispelling such an attitude of mind. Moreover, a great trade has developed in the sale and exchange of small producing leases both fully and partly developed, undeveloped acreage near to producing wells and "wildcat" leases in more speculative areas. There are, in many centres, brokerage establishments which do no other form of business. The independent geologist has become an important factor in such transactions. Not only is he called upon to furnish reports on the structural conditions and prospects of such areas, but he has frequently to examine the present condition and productivity of the oil and gas wells which may be present, to inquire into their history, forecast their future, discover possible presence of water, estimate the possible future encroachment of water, lay down a programme for future development, set forth the number of wells that may still be drilled on the property and the production of oil that may be obtained therefrom, calculate the effects of offset drilling on neighbouring properties, in short, examine and report on all factors upon which a scientific valuation may be founded and usually to suggest the actual present value of such properties to his clients.

Finally, the exigencies of the Federal Income Tax Commissioners have created a situation which frequently leads to calls upon the services of the consulting geologist. It is obvious that the income derived from the production and sale of oil on most small properties may be represented by a downward curve, which must touch zero in a few years' time, that is, production will decrease until it is unprofitable to continue work upon the wells and the property is abandoned. The producer is therefore allowed to amortise his income tax on the basis of the probable life of his wells and his diminishing returns. For this purpose it is necessary to call in an independent expert to make an examination and prepare the necessary details for the Income Tax Commissioners, and in most cases the results are accepted by them.

THE FARADAY SOCIETY.

The following paper was read at the meeting held on January 26 :—

On the Velocity of Chemical Reaction in the Silent Electric Discharge. By G. A. Elliott, M.Sc., Ramsay Memorial Fellow; S. S. Joshi, M.Sc.; R. Winstanley Lunt, M.Sc., Ph.D.; 1851 Exhibition Senior Student. Communicated by Professor F. G. Donnan.

Despite the numerous investigations that have been made on chemical changes produced by an electric discharge through a gas, no satisfactory general hypothesis has yet been suggested to describe the mechanism of such changes. In this communication an hypothesis is advanced which leads to an expression relating the velocity of such chemical reactions to the gaseous pressure and to the electrical factors which determine the discharge.

The fundamental idea from which this expression is derived was suggested by Professor F. G. Donnan, F.R.S. It is that the velocity of such chemical reactions might

be associated with the number of collisions between ions and gas molecules in which the energy of the ion is equal to, or exceeds a certain critical value. This value can be regarded as the critical energy of activation associated with the particular reaction concerned. According to the collision theory of chemical reaction, the rate of chemical change in a gas is a function of the kinetic energy of the constituent particles; and it is immaterial whether the kinetic energy is of thermal or electrical origin. The concept of critical activation energies may therefore be applied to chemical reactions in which *the energy necessary to effect chemical* change is of electrical origin. It will be assumed, in order to simplify the discussion, that the radiations arising in the discharge produce no chemical changes.

Under normal conditions the number of charged particles existing in a gas is known to be very small. When a gas is subjected to an electric field the energy acquired by the ions during their free paths increases with the field strength. When this energy is equal to, or greater than a certain critical value, known as the ionisation potential when expressed in volts, new ions are produced by collision and the number of charged particles in the gas increases rapidly. Since the increase in the average kinetic energy of all the particles in the gas depends on the number of ions and on the field strength, no appreciable chemical change may be anticipated until ionisation by collision occurs. This deduction is in agreement with experimental observation. When ionisation by collision takes place the electrical conductivity of the gas increases markedly and the gas is usually seen to glow.

Consider 1 c.c. of gas, at a pressure p, which is subjected to the discharge for a small time period, T. If N is the number of ion pairs per c.c., and v is their average velocity in the direction of the electric field, then $2NvT$ is the total ionic path traversed while the gas is subjected to the discharge. An ion which travels a distance x cms., in the direction of the field, E, acquires an energy Eex due to the field, where e is the ionic charge. If the critical activation energy for the reaction concerned is V_0e, then x_c, the corresponding critical ionic path, is equal to V_0E^{-1}cms.

According to classical kinetic theory, which is assumed valid under the conditions obtaining in the discharge, c, the number of collisions of an ion per centimetre of its path which terminate free paths equal to or greater than x_c is given by

$$c = C.e^{-\frac{x_c}{l}} = C.e^{-\frac{V_0}{lE}}$$

where C is the total number of collisions per centimetre of ion path, and l is the mean free path of the ion. Therefore the number of molecules of gas chemically changed, per c.c. in time, T, is

$$2NvT.Ce^{-\frac{V_0}{lE}}$$

and K, the velocity of reaction or the number of molecules changed per second, is given by

$$K = 2Nv.Ce^{-\frac{V_0}{lE}} \quad . \quad . \quad (1)$$

Since C, the number of collisions per centimetre of ionp ath is proportional to the pressure, p, it may be expressed by

$$C = kp$$

where k is a constant. Substitution of this expression for C in equation (1) gives

$$\frac{K}{p} = 2k.Nv.e^{-\frac{V_0}{lE}} \quad . \quad . \quad (2)$$

In order to apply this equation to experimental results, it is necessary to know the manner in which Nv varies with p and E. Equation (2) may then be used to calculate V_0, the critical energy, from values obtained experimentally for K, the initial velocity of reaction at various pressures and in a constant field, E. It is necessary to identify K with the initial velocity of reaction, since the nature of the gas will have changed after the commencement of the reaction and, therefore, Nv and l will have different values.

In many experiments on the chemical change produced in a gas by the action of an electric field sustaining ionisation by collision, it is found convenient to enclose the gas in an insulating envelope of glass or silica, whereby the gas is separated from contact with the metal electrodes. By this means any possibility of the formation of metallic arcs, or of specific catalytic action by the metal electrodes, is obviated. A typical example of such a device is the familiar Siemen's Ozoniser in which the insulating envelope and the electrodes are concentric cylinders. It is now proposed to discuss briefly the application of equation (2) to experiments carried out in this type of discharge vessel.

Such a discharge vessel can be considered as a system of three capacities in series, two associated with the dielectric walls and the third with the annular space containing the gas. A current will flow through the ozoniser if an alternating potential, V, is applied to the electrodes and, if this potential exceeds a certain value, ionisation by collision will occur in the gas. The conductivity due to the ions in the gas may be represented by the inverse of a resistance term shunting the third condenser. From known values of V, of *P*, the power developed in the gas, of I, the total current and of the frequency of alternation, it is possible by vectorial analysis to evaluate V_g, the r.m.s potential across the gas space, and *i*, the r.m.s. value of the current carried by the ions. If *d*, the width of the annular space, is small compared with the radii of the walls, then E, the field in the gas, is at any instant approximately uniform and its r.m.s. value is given by $V_g d^{-1}$. It may be mentioned that the ratio VV_g^{-1} is determined by the dimensions of the ozoniser and by the nature of the gas.

The current *i* per square centimetre carried by the gas can be expressed in the form familiar in electrolysis,

$$i = (U^+ + U^-)\,Ne$$

where U^+ and U^- are the velocities of the positive and negative ions respectively, in the field E, sustaining the current *i*, Therefore

$$i = 2vNe$$

and $$Nv = i/2e$$

where *v* is the mean velocity of the ions. Hence equation (2) may be written :

$$\frac{K}{p} = \frac{k}{e}.i.\epsilon^{-\frac{V_0}{lE}} \quad . \quad . \quad (3)$$

Now *l*, the mean free path of the ions, is equal to $\frac{1}{C} = \frac{1}{pk}$, and substitution in the above equation gives

$$\frac{K}{p} = \frac{k}{e}.i.\epsilon^{-\frac{pkV_0}{E}}$$

which may be written

$$\frac{kV_0}{E} = \frac{1}{p}\left\{\log\frac{k}{e} + \log i - \log\frac{K}{p}\right\} \quad . \quad (4)$$

In this latter form the equation may most readily be tested by experiments carried out with a constant field, E. For then $\frac{kV_0}{E}$ is constant and the expression on the right, in which all the quantities may be determined, should also be independent of pressure.

In some experiments carried out in these laboratories it has been shown that the conduction current, *i*, measured for a constant value of the field on the gas, does not vary greatly over a limited range of pressures. For this case therefore we may write :

$$p.\frac{kV_0}{E} = A - \log\frac{K}{p} \quad . \quad . \quad (5)$$

where $A = \log\frac{k}{e} + \log i$, and is constant.

$\text{Log}\,\frac{K}{p}$, and *p* should therefore be linearly related (E constant); this conclusion has been experimentally confirmed.

It is interesting to consider an alternative expression in which the product N*v* is expressed as a function of P, the power developed per c.c. in the gas, which is equal to the product of the field strength and the ionisation current per square centimetre. That is P = E*i*; consequently, substitution of this expression in equation (3) gives

$$\frac{K}{p} = \frac{k}{e}.\frac{P}{E}.\epsilon^{+\frac{V_0}{lE}} \quad . \quad . \quad (6)$$

Equations (4) and (6) thus relate in a most general way the velocity of reaction and the critical activation potential to the gas pressure, the mean free path of ions producing activation and the electrical factors determining the discharge.

In conclusion the authors desire to express their sincere thanks to Professor F. G. Donnan, F.R.S., for his active interest and valuable criticism during the development of this theory.

BATTERY ELIMINATORS, OR APPLIANCES FOR THE OPERATION OF RADIO RECEIVING APPARATUS BY ENERGY DERIVED FROM ELECTRIC SUPPLY MAINS.

By PHILIP R. COURSEY, B.Sc., Member, AND H. ANDREWS, B.Sc. Graduate.

(Before the Institution of Electrical Engineers.)

SUMMARY.

The paper describes the essential features of the apparatus required for the supply of electrical energy of suitable voltage for the operation of radio receiving apparatus, by the utilisation of public electric supply system. The common features, and the

differences between apparatus for d.c. and for a.c. supplies, are pointed, and the leading features of the design of the filtering system are given. Experimental investigation of the electrical properties both of the filter circuits and of the complete supply appliances are described.

Descriptive names are proposed for these devices, and suggestions are made with regard to the proper rating of these appliances in terms of their output. The need for such rating is emphasised, together with the difficulties of properly expressing all the factors involved.

Rectifying arrangements are described for use on a.c. circuits, and the paper concludes with a consideration of the precautions necessary in the use of apparatus of this type.

Lister's Work for Humanity.

The Lister Centenary has been celebrated in medical and scientific circles with due solemnity. In all of them mankind's debt to the great medico-scientist was shewn in strong relief. On April 6, at a meeting of the Royal Society, just tributes were paid to Lister and his work.

Sir Ernest Rutherford, president of the Royal Society, occupied the chair, and said Lister's discovery of antiseptic surgery was one of the most striking examples of the power of scientific methods in advancing knowledge. In Lister they had the most unusual combination of a philosophic outlook and great power of experiment with a strong command of technique.

Sir Charles Sherrington, referring to Lister's physiological work, spoke of his early papers on various muscles and on the coagulation of blood, and said that almost from the outset of his career he had not only found, but flung himself upon, what was to be his life-work. In addition to his earlier papers, he had enriched physiology with an advanced means for doing its work. He put into its hands for all time a superlative refinement of its methods and made possible observations which had hitherto been impossible. How could Pavlov have made his epoch-opening study of the digestive processes except by leaning on Lister's surgical principles? How could the physiologists of Toronto resently have bestowed on diabetic sufferers the merciful remedy insulin, but for the aid which Lister's methods gave? While helping man to mastery over disease, Lister contributed to free experimentation from the infliction of pain. Man, sacrificing animal life as he did, to satisfy human need, had the right to regard the intellectual and moral impulse driving him to mitigate and dominate disease as justified in its resort to animal experimentation. He felt the more fully justified in so doing and took that step with a free conscience, largely because, owing to Lister, it could be done without inflicting pain or causing suppuration.

Three Pre-eminent Names.

Professor *William Bulloch* (London Hospital) who dealt with Lister's work as a bacteriologist, said the best of his scientific work was not done in any laboratory, but at home in the early morning and late at night, before and after a harassing day's surgical work. The construction of his antiseptic system took place in Glasgow. The work of Pasteur came to Lister as a revelation, and almost at once he grasped the full significance of it for surgery. It was a vulgar error to regard him as a mere imitator of Pasteur. Four years before he knew of Pasteur's work he was getting extraordinarily near the truth as to the cause of suppuration, and he afterwards advanced far beyond the point to which the Frenchman had led him. He was a master of the experimental methods. No one could come into contact with him without being impressed by his noble personality, his magnanimity, his liberality, and his wonderful modesty. In the art of medicine three names stood pre-eminent. They were William Harvey, Edward Jenner, and the great Lister.

Sir Berkeley Moynihan, president of the Royal College of Surgeons, said the work of Lister, which had conferred upon him immortality, had done for the craft of surgery what John Hunter did for the science of surgery. One of the striking features of the work of both Pasteur and Lister was that it centred round a utilitarian purpose. By his research work, Lister placed himself in the direct line of English tradition. His earlier work owed a great deal to John Hunter. When he learnt almost accidentally of the work of Pasteur, his mind was open to the new truth, and almost expectant of it. His first attempt was to destroy within the wound the micro-organisms which caused putrefaction and decomposition. His later attempts were to destroy those organisms as they were about to enter

the wound and ultimately to destroy them in the whole field of operation before they had a chance to enter the wound. The search for the perfect bacteriacide was still going on. There had grown up in surgery a comparison of two methods—antiseptic and aseptic. They realised now that the conflict between the protagonists of the two was senseless and jejune. " I do not recognice the existence of aseptic surgery," said Sir Berkeley Moynihan. " I have never performed an operation in which antiseptics were omitted. Aseptic surgery is only the sensible practice of antiseptic surgery. They do not differ in ideas but only in the methods of their perfect accomplishment."

Speaking of the opposition offered to Lister's work, he said some minds were impervious to novelty; truth seemed to be bent at an angle as it entered the rather denser medium of those minds. (Laughter.) The immediate result of Lister's work was the perfecting of the old operations. New operations also became possible, but the most marvellous feature of the advance made possible was that surgery became a great implement of research, how great was not realised even to-day by surgeons or physiologists. For a time the physiologist had gone astray and did not walk, as he should, hand in hand with the surgeon. The science of surgery was now so much in advance of the sciences on which it depended that until these caught up it must for a time be stationary. Surgery had rewritten the textbooks of medicine concerning the visceral diseases. It had put into the hands of all a method, curiously neglected even to the present hour, of explaining most of the diseases which were still classed as medical.

Infection in Medicine.

The influence which Lister's work might have on surgery was almost completed. They were at the end of the possibilities which resulted from the change Lister brought about. They could hardly make surgery safer than it was to-day, but Lister's hypothesis, which governed the practice of surgery, was at least of equal importance in relation to medicine. Infection in medicine was responsible for a vast number of diseases, a number much greater than appeared to be realised. Here again there had been apathy. The discovery of infections and their influences shown in 1900 as the result of a great many years of work by William Hunter had received far less attention than it ought to have had. While they were slandering their ancestors for their indifference to Lister, let them remember that the same indifference had been shown by them to one of their own contemporaries.

Lister had done more than all this. The nations of the earth were for ever at war. Were there not between them all bonds that should unite them so strongly that they could not be separated, and was there any bond between the nations so strong as that which Lister had forged? Had they not seen in London during the last few days a league of all the nations? Was it not possible that, because of their love for Lister and in the common, reverent service to humanity which Lister made possible, they might find a way to heal the wounds not only of men, but of nations? If they could do that they might be the heralds of a new day when there should be no more war, and then the Quaker spirit of Lister, which loathed the drums of war, might for ever be at peace. So long as men should suffer, Lister would be there to heal them and to hold the gates of life ajar. His living memorial would be the great and ever greater multitude of men, women, and children of every nation and race, released by his gentle hand from infirmity, suffering, and sorrow, and made for a time triumphant over death.

NOTICES OF BOOKS.

Essays on the Art and Principles of Chemistry, Including the First Messel Memorial Lecture. By Henry E. Armstrong, Emeritus Professor of Chemistry. Pp. xxx + 276. Price 15s. nett. London: Ernest Benn, Ltd.

This is a book out of the common. The author soon gains the attention and secures the attention of even the non-scientific reader by the simplicity of his language and the lucidity of his explanations. His style is chatty, and his method of treating the various phases of his subject is invariably within the grasp of the average layman. As the book advances there is given sufficient science to interest even votaries of science. The author gives a good deal of information, both scientific and historical, in the long preface, and he seeks to inculcate on the part of the chemist a little more reason and independence of thought. The book is both informative and interesting, both for what it contains and the style of the author.

FORTHCOMING EVENTS.

THE ROYAL INSTITUTION.

Friday, April 29, at 9 p.m.—" Wireless Transmission and the Upper Atmosphere." By Edward V. Appleton, M.A., D.Sc.

THE FARADAY SOCIETY.

Friday and Saturday, April 22 and 23.—General Discussion on " The Theory of Strong Electrolytes," to be held in the Department of Biochemistry, University Museum, Oxford. Chairman, Prof. C. H. Desch, D.Sc., F.R.S.

ROYAL SOCIETY OF ARTS.

John Street, Adelphi.

Monday, April 25, at 8 p.m.—(Cantor Lecture). John W. T. Walsh, M.A., M.Sc., F.Inst.P., A.M.I.E.E., Senior Assistant, National Physical Laboratory, and General Secretary, International Commission on Illumination : "The Measurement of Light" (Lecture I.).

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment.

Thursday, April 21, at 6 p.m.—Prof. E. W. Marchant, D.Sc. The Eighteenth Kelvin Lecture. " High Frequency Currents."

BRITISH SCIENCE GUILD.

The British Science Guild dinner will be held at the Criterion Restaurant, London, on Thursday, May 12, when the Rt. Hon. Lord Askwith, K.C.B., K.C., will preside. Speakers and other guests include The Rt. Hon. Sir Alfred Mond, Bart, P.C., M.P.; The Rt. Hon. Sir Herbert Samuel, P.C., G.B.E.; General Sir George Milne, G.B.E., G.C.M.G., K.C.B., D.S.O.; The Hon. W. Ormsby-Gore, M.P.; Sir William Pope, K.B.E., F.R.S.; Sir Frederick Keeble, C.B.E., F.R.S.; The Rev. Prebendary Gough.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

7,778.—I. G. Farbenindustrie Akt.-Ges. Process for absorbing ammonia, etc., from gases. March 21st.

8,300.—Holzverkohlungs-Industrie Akt.-Ges.—Concentrating raw pyroligneous acid. March 25th.

8,017.—Newbery, G., and May & Baker, Ltd.—Manufacture of oxyacetic acid derivatives of arylarsenic compounds. March 23rd.

8,268.—Koppers, Co.—Manufacture of coal products. March 25th.

8,138.—I. G. Farbenindustrie Akt.-Ges. —Production of vat dyestuffs. March 24th.

Specifications Published.

249,489.—Soc. of Chemical Industrie in Basle.—Manufacture of intermediate products of the anthracene series, and dyestuffs therefrom.

267,721.—Toniolo, C. — Manufacture of nitric acid.

267,071.—Allgemeine Ges. fur Chemische Industrie. — Process of refining mineral oils with liquid sulphur dioxide.

252,367.—I. G. Farbenindustrie Akt.-Ges. —Process for utilising the residue obtained in the reduction of molten crude phosphates.

257,622.—Consortium fur Elektro-Chemische Industrie Ges.—Manufacture of metals.

Abstract Published.

265,336.—Lactic acid and lactates.—Faithfull, S. E., 528, Ridgewood Road, West Orange, New Jersey, U.S.A.

Lactic acid and lactates are produced by fermentation, a gaseous oxidising material containing free oxygen being introduced to retard the production of butyric acid, and impurities being removed from the lactate solution after fermentation. In an example a hydrolysed carbohydrate (glucose) is subjected to fermentation with lactic bacteria in slightly acid solution. Slaked lime or calcium carbonate is added to neutralise the acid formed and oxygen or air is injected during the fermentation and as long as calcium lactate is present in the liquor. The solution is then made slightly alkaline and then heated nearly to boiling point, which converts any carbohydrates remaining into caromel, which can be filtered off. The solution is concentrated, acidified and lead lactate or other lead salt or tannin is added to precipitate the nitrogeneous matter present, from this, after filtration, nitrogen may be recovered as ammonia by heating. The solution may be purified by activated carbon and any heavy metals precipitated with sulphuretted hydrogen leaving a colourless solution of calcium lactate, from which calcium lactate, calcium acid lactate or lactic acid may be obtained in known manner.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ICYL.

477,593.—Synthetic dyestuffs in Class 1, for use in dyeing.—British Dyestuffs Corporation, Ltd., 70, Spring Gardens, Manchester. March 30th.

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AN ATOMIC MODEL FOR THE CHEMIST. III.

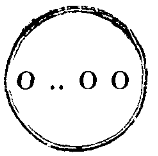
By FLORENCE LANGWORTHY.

Major Planets.						Minor Planets.
Li	Be	B	C	N	O	O F
O	O	O	O	O	O	4 :
.O.	.O.	.O.	.O.	.O.	.O.	O

Sun Atom

Coronal Electrons.

Li	Be	B	C	N	O	F
..	..	..	..	..	..	...
6	8	10	12	14	16	19



2

Above we have a rough diagram of the isotoped fluorine atom. For convenience the electrons are shown as smaller than the positive particles and orbital signs have been omitted. *The fluorine positive, since* it is held by the two electron-planets, is practically a negative atom—a positive with two electrons—and so it can, in its turn, hold up another positive. The two coronal electrons of this isotope positive have ousted one of the coronal electrons of the fluorine positive and thereby raised the atomic weight from 18 to 19. They have done more than this also, for it is now the coronal electrons of the isotope that are nearest the sun-atom, and so it is that positive that is most affected by whatever takes place in the atomic sun. The true planet, the fluorine positive, therefore, is cut off from the central stimulus and so we may picture it as being more or less dormant like the other planets. But when the atom is exceptionally excited, this positive is also aroused and then, as there will be two positives pulling equally upon the coronal electrons, there will be a change in the atomic weight; it will be halved. Dr. Aston tells us that fluorine has a strong line at 19 with a second-order line at 9.50. Some of the sun's rays are apparently damaging fluorine to a great extent since we have not, so far, come across a fluorine 18. Magnesium X-rays would be puculiarly dangerous to fluorine.

Second-order lines that are not true second-order lines can seemingly make their appearance. When the fluorine planet and its isotope depart they are not able to take the electron-planets with them since they belong to the sun-atom. To repair the damage done it would be necessary for the sun-atom to attract a negative particle before the ionisation of the electron-planets—due to the loss of the two positives—dies down, for otherwise the positive that is thrown into the atomic system will be attracted instead to the lively negative of the chief planet—now the oxygen planet. But it is not easy for the sun-atom in such a negative system as the oxygen atom to attract a negative particle. If, then, some little time elapses before the negative particle is attracted, the planet cannot be reinstated. For with their positive wandering off to the wrong orbit—the oxygen orbit—the two electrons will be dragged from their orbits in the corona and this will en-

tail repulsion out of the atom. If at such a moment the atom is strongly excited, we can understand that there will be two positives in the oxygen planet pulling equally upon the coronal electrons and a second-order line at 8 will be shown. But it will not be a true second-order line for the positive will not be able to retain its hold upon the negative particle seeing that it has no electrons in the corona to hold it in place. As soon as the excitement of its union with the negative dies down the sun-atom will be able to repel it out of the atom. But we will leave consideration of these stray ' held-up " atoms until we come to the twin systems in which they can apparently be held up long enough to affect the atomic weight in no transitory fashion.

It may be thought that when once the oxygen planet has gained a true isotope then it should be an easy matter to replace the missing fluorine planet since the oxygen atom with a double-positive charge will be able to attract particles without difficulty. Not only, however, has some time elapsed in all probability before the oxygen planet is thus isotoped so that all traces of ionisation have left the electron-planets, but we must also take into consideration the fact that as oxygen comes next to fluorine the electron-planets will have for neighbour this oxygen planet and therefore on any single positive being thrown to them it will have to face this double-positive repulsion in its neighbourhood. In this way, then, we can account for the planet's not being replaced while the atom is oxygen. And when the oxygen planet, in its turn, departs, then every chance of reinstating the positive with the electron-planets also departs, for the oxygen coronal electrons that would have kept the coronal electrons of the positive in place—if the said positive had not wandered—are gone. Thus the sun-atom is unable to replace its planets although with the breakdown of each planet it is more and more easy for the sun-atom to attract negative particles since the atom becomes more and more positive.

The sun-atom in the atoms of each element will, therefore, when excited, be attracting into the sun-region negative particles which cannot be held in position. On escaping from the atoms of different elements these particles will have different frequencies. A negative particle that has been " occluded," for instance, by the sun-atom in a boron atom will have had its electrons temporarily in what was the orbit of the coronal electrons of the carbon planet, and so if the positive is immediately repelled—as when it was confronted by a double-positive planet —then these electrons that follow it will have had this orbit impressed upon them. We thus possibly have a glimpse as to why it is in catalysis that some elements are better catalysts than others. In some cases they may be throwing off more of these excited particles, while in other cases they may be throwing them off at a frequency that is better for the purpose in hand. For if of the right frequency they will be able to ionise an atom by turnits chief planet into a double-positive.

On the flight of the fluorine planet with its isotope with their three coronal electrons as an L X-ray, we shall have an L X-ray that is different from the L-ray yielded by major planets inasmuch as that this fluorine L-ray will be a compound ray consisting of the isotope positive with its two electrons revolving about it with their impressed frequency, and the fluorine planet positive with its one remaining electron revolving about it with its impressed frequency. This ray will thus consist of two different parts and therefore will not hold together but will, on passing out of the ray state, part company as a negative particle and a neutral particle.

The departure of the fluorine planet and its isotope with the coronal electrons, 19, 18, 17, left the atom oxygen (16.0). It is a strong negative for there are six negative particles in the atom which more than counter-balance the double positivism of the sun-atom. But the entry of a K-ray puts the negative particle of the oxygen planet out of action by turning the planet into a double-positive. For the entry of the ray has entailed the loss of a coronal electron to the planet and this loss has ionised the planet with the result that its excitement is communicated to its negative particle. The latter therefore has no difficulty in attracting to itself the positive of the ray, which, repelled by the sun-atom but held by its electrons—is somewhere in its vicinity. The atomic weight has gone up to 17, thanks to this isotope with which the planet now has to share its negative particle. It will be asked why the new positive does not attract a negative particle of its own as the planet did. The answer apparently is that it cannot hold up a negative particle because of the repulsion of this negative about which it revolves. Or at least that it cannot hold such a particle near enough to prevent the sun-atom from attracting it away. It may be argued that since the planet is now a

double-positive it should be able to hold up the negative particle against the attraction of the sun-atom. But the planet is not a true double-positive like the sun-atom. The latter has two positive charges without any intervening negative. They are repelling each other and so are at a distance from each other ,but still they are—owing to the formation of the atom—two positives without any negative between them to modify this double-charge of positivism. The planet, on the other hand, has this intervening negative and it would be better described as a planet with two positive charges than as a double-positive. Away from the atom this planet would not be a double-positive since part of its strong effect will be due to the sun-atom. The latter we may be sure will not be so quiescent when it is confronted by a planet containing two positive charges as it was when the planet consisted of one positive and a negative. So that the strong positivism of such a so-called double positive atom will not be entirely due to the planet. And as the system breaks up so the sun-atom's share increases, seeing that each planet on departing will be taking away one of those negative particles that have been weighing down the scale against the double-positive sun-atom.

If the isotope positive could hold up a negative particle then the atom would be a double-negative instead of a double-positive Sir Joseph Thomson, however has told us that in all his experiments he has never come across a double-negative atom although he has come across so many double-positive atoms. So that any atomic model that shows us a double-negative atom is not to be trusted. We saw, too, that the atom becomes more and more positive as it increases in weight—that chromium is more positive than sulphur and that selenium is more positive than chromium, etc. Twin-elements were indicated as the cause of this. As we shall see there are two chlorines owing to an extra positive being introduced into the atom, although the first true twin is selenium. If an outer twin could hold up a negative particle then the atom would not become more . and more positive as described.

It is the isotope positive, I venture to think, that, when it is attached to a major planet, makes the atom diamagnetic. Oxygen is not, apparently, easily damaged and so is practically paramagnetic. But Sir Joseph Thompson does occasionally come across an oxygen atom with a double-positive charge. Such an isotope, attached to a major planet, is not, we may be sure, in the most desirable of positions, repelled as it is by the planet and by the sun-atom. Its only friend is the negative particle attached to the planet. Its orbit will therefore be one that follows the path of least resistance, in other words it will avoid the plane of the ecliptic as much as possible, its orbit, instead of being in that plane will be at right angles to it. The shock, too, that the planet experiences when thus saddled with another positive—with the consequent sudden repulsion of the sun-atom—evidently has the effect of making the planet revolve in the opposite way. So that now the chief planet in the atom, say, for instance, the boron atom, revolves in clockwise fashion, whereas the other planets are revolving in counter-clockwise fashion. Before the boron planet received the extra-positive—and so was mildly negative—it was revolving like its fellows and it was not avoiding the equatorial plane. Now it not only revolves contrariwise but avoids the equatorial plane and its central sun as well. It is diamagnetic now, not paramagnetic. If we place diamagnetic atoms in the proximity of the atoms of iron, nickel or cobalt —when the sun-atoms therein are lively, as in a magnet—they will retreat from the same. They are free to do so. A diamagnetic planet, however, is not thus free, since its coronal electrons are held up in the sun-region. All that it can do is to try to avoid the equatorial plane as much as possible. Seeing that the minor planets cannot become double-positives in this fashion, we shall not expect such atoms as fluorine atoms, iron atoms, etc., to be diamagnetic. It is true that the fluorine planet has been shown as holding up an isotope, but that does not make it a double-positive. It is merely a negative particle (a positive particle with two electron-planets) holding up a positive. These minor planets, therefore remain more or less neutral when isotoped and so the sun-atom does not repel them. An isotoped major planet has three positives to two electrons (two positives and one negative particle) and an isotoped minor planet has two.

If an electron of dangerous frequency had sent the oxygen planet flying from the atom as a K X-ray— that is to say before it was isotoped—then the ray would have consisted of the positive planet, the negative particle and two electrons of an impressed frequency. On escaping from the atom the positive would be probably drawn by the

attraction of the whirling electrons of the negative particle into an orbit about it. The pull of the two outer electrons will give it the weight of 2 and it looks as if the combination on passing out of the ray state—if not absorbed—settles down into becoming a negative atom of hydrogen, even as the Alpha ray settles down into becoming an atom of helium. Should, however, the ray be absorbed, say by an undamaged carbon atom, then the two outer electrons will evict one of the carbon coronal electrons and take up their orbits in the carbon coronal orbit while the positive—unable to approach so near to the sun-region—will be repelled among the planets and will attach itself to the excited negative of the ionised carbon planet, which proceeding will cause it to lose the negative about which it has revolved

We have pictured the entry of a K X-ray as putting the negative particle of our oxygen planet out of action by turning the planet into a double-positive. Let us now suppose that a major planet L X-ray of a dangerous frequency enters the atom. It is of long wave-length, comparatively, consisting as it does of two positives united by a negative particle, with three electrons, revolving about it. When such a ray enters an atom it apparently ousts the chief planet totally and takes its place. Here, then, we should have a case of substitution, save that the substituted planet is an isotoped planet which the ousted planet may not have been. Seeing that the L X-ray is in a far livelier and therefore more vigorous condition than the planet, it is hardly surprising that should pass by our atom we can well believe that the electrons attached to the negative particle of the lithium planet will swing out towards it. Here we seemingly have Sir Joseph Thompson's Delta rays. But these electrons will suffer repulsion on coming too near to the double-positive from the hidden electrons of the latter and so will swing back to their proper orbit. Such electrons, though they may temporarily leave the atom are not really leaving it nor are they to be described as travelling at a high speed. They have not been forced into an orbit that is too near to the electrons of the sun-atom. They are comparatively free.

It was Professor Barkla who showed us that from each element came two characteristic radiations, the hard K series, as he called it, and the softer L series. But we have also to take into consideration the fact that the hardness of the K X-rays will increase with the atomic weight and therefore the K X-ray that our oxygen atom would yield if the oxygen planet left the atom before it was isotoped would be a " soft " ray compared with such a ray from heavier atoms. For since our oxygen K X-ray comes from a very light atom it will not have the energy possessed by the K X-rays from heavier atoms, not to speak of the tremendous energy of the Gamma rays—the X-rays of highest frequency—from the radio-active atoms—the heaviest atoms of all.

We have, however, isotoped our oxygen planet and so it will depart as an L X-ray. This entails the atomic loss of coronal electrons ,17, 16, 15, and the atom becomes

attraction of the whirling electrons of the negative particle into an orbit about it. The pull of the two outer electrons will give it the weight of 2 and it looks as if the combination on passing out of the ray state—if not absorbed—settles down into becoming a negative atom of hydrogen, even as the Alpha ray settles down into becoming an atom of helium. Should, however, the ray be absorbed, say by an undamaged carbon atom, then the two outer electrons will evict one of the carbon coronal electrons and take up their orbits in the carbon coronal orbit while the positive—unable to approach so near to the sun-region—will be repelled among the planets and will attach itself to the excited negative of the ionised carbon planet, which proceeding will cause it to lose the negative about which it has revolved

We have pictured the entry of a K X-ray as putting the negative particle of our oxygen planet out of action by turning the planet into a double-positive. Let us now suppose that a major planet L X-ray of a dangerous frequency enters the atom. It is of long wave-length, comparatively, consisting as it does of two positives united by a negative particle, with three electrons, revolving about it. When such a ray enters an atom it apparently ousts the chief planet totally and takes its place. Here, then, we should have a case of substitution, save that the substituted planet is an isotoped planet which the ousted planet may not have been. Seeing that the L X-ray is in a far livelier and therefore more vigorous condition than the planet, it is hardly surprising that it should evict it—if of the right frequency. And when an L X-ray expels a planet that has not been isotoped, the ray will have three coronal electrons, wherewith to repel out of the corona the planet's two. This absorption will naturally cause the atom to be—for the time being—in a highly excited state. The sun-atom has been roused and this, in its turn, will arouse the other planets so that it is not only the chief planet that is affected.

To put it briefly, then, we shall expect that when an L X-ray is absorbed by one of our major planet atoms then the response will be an evicted planet—an X-ray, but that when a K X-ray enters an atom and is absorbed by it the response will be a high-speed electron.

It is necessary to distinguish between the electrons that come from the corona and those that come from other parts of the atom. If, for instance a double positive atom should pass by our atom we can well believe that the electrons attached to the negative particle of the lithium planet will swing out towards it. Here we seemingly have Sir *Joseph Thompson's Delta rays*. But these electrons will suffer repulsion on coming too near to the double-positive from the hidden electrons of the latter and so will swing back to their proper orbit. Such electrons, though they may temporarily leave the atom are not really leaving it nor are they to be described as travelling at a high speed. They have not been forced into an orbit that is too near to the electrons of the sun-atom. They are comparatively free.

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We have, however, isotoped our oxygen planet and so it will depart as an L X-ray. This entails the atomic loss of coronal electrons ,17, 16, 15, and the atom becomes nitrogen 14 (A.W. 14.0).

MILLER'S EXPERIMENTS AND THE CONSTITUTION OF MATTER. III.

By W. Tombrock.

R. J. Kennedy, National Research Fellow in Physics (*Proc. Nat Acad. Sci.*, XII, 621, 1926), attempts to test the results of Miller with an altered apparatus which otherwise rests on the same principle.

He places "the whole optical system"—glass plate and reflecting mirrors—"in a sealed metal case containing helium at atmospheric pressure." By this means the light paths are greatly decreased.

He attempts to regain the sensitivity of the apparatus (considered as theoretically perfect) which is much reduced at the same time "by an arrangement capable of detecting a very slight displacement of the

interference pattern "—therefore a refined interferometer.

" As has been shown, a shift as small as one fourth of that corresponding to Miller's would be perceived " (*loc. cit.*).

It cannot be denied that Miller's apparatus which is constructed with a long light path in which the resolved perpendicular components of the light ray must traverse a long path before they unite again in order, by means of the interference phenomenon, to reveal a possibly existing phase difference, that this apparatus must indeed be very sensitive to changes of temperature and pressure. Hence single observations must differ considerably from one another.

But on the other hand stands the fact that Miller makes thousands of observations and takes the mean thereof.

And note well : Miller could not at first make any progress with his gigantic observational material collected in different parts of the year, thus practically the whole year through.

Miller could thus make no progress until the idea occurred to him to arrange this material according to sidereal time.

Then he obtained an unmistakable indication in his results, to wit, curves which clearly pointed to a cosmic origin.

Hence we can thus summarise : —

Miller arranges his results according to sidereal time.

Miller takes the mean of thousands of observations.

Miller then obtains curves which incontravertably point to a cosmic origin.

Miller thus obtains a positive cosmic results. Kennedy obtains absolutely no, thus a completely negative, result.

In this Miller works with a much longer light path (according to Kennedy with a light path of 65 metres against a light path of 4 metres in Kennedy's work). Against that Kennedy works with a better apparatus and a refined interferometer.

Let us now just make the assumption that Kennedy's apparatus, being here actually conclusive ,is , theoretically perfect and furthermore that Miller's result is an error. What then follows?

It is simply absurd to ascribe to chance such clear curves as Miller has deduced from the mean of thousands of observations. And observe, that when it was but a single curve which might by chance agree with the theory . . . but these are *two* curves of observations which do this, namely that of the observed magnitude and that of the observed direction.

Thus *then Miller has made an error which is of cosmic origin*, in other words, *then* his error must be caused by a motion of our solar system (of the sun !).

Does not this singular conclusion, that there must be here *an error of cosmic origin*, bring strongly to the front the question of whether the statement of the problem is here really correct?

When you say here, " Kennedy is right —thus Miller is wrong," do you not implicitly (tacitly) presume that you already know everything about the structure of ether and light?

When you say here, " Kennedy is right—thus the results of Miller are erroneous," do you not, so to speak, make these results conform to your theory Is that not here an incorrect statement of the problem? Would it not be better in this case to make the theory conform to the results of the experiment? In other words ,would it not be better, when you attempt to construct a theory to make one which assumed a structure of the ether and light capable of explaining Miller's result and that of Kennedy?

Light is to explained quite materially or light is not at all explained. Ether is to be explained away; this means that the ether without however being molecular or even atomic is to be considered as a gas. And the atoms of a light source are like revolving machine guns shooting electrons.

PROPOSITIONS.

7. The visual impression of ordinary objects is also caused by the rotary motion of their protons, that is to say ,by the ether particles (electron transmission) which they themselves hurl off by this motion.

8. Undulation is caused by the rotational movement of the emitted (transmitted electrons.

9. Gravitation is caused by electron transmission.

10. Protons are larger material particles which rotate strongly but have little translational motion.

Electrons possess both a rotation and a more or less considerable translational motion.

Picard et Stahel, Comptes Rendus, 183, 4 20 (1926) et 184, 152 (1927).

Brylinsky, C. R. 184, 197 (1927).

NEW GERMAN CHEMICAL FERTILISER.

After many experiments, and by the fruitful co-operation of science and practice, of chemists and farmers, the J. G. Farbenindustrie has now succeeded in combining the three essential plant-foods, nitrogen, phosphoric acid and potash, into a new chemical fertiliser. Having been exhaustively tested, the new product, called "Nitrophoska J. G.," is now on the market.

The new compound fertiliser seems destined to remove the many difficulties connected with artificial fertilising. Nitrogen prosphoric acid and potash have, of course, long been used by farmers as fertilisers. They were applied in two ways ;either they were put into the ground separately, or mixed in certain proportions according to the nature of the soil. If applied separately, potassium salt of 100 per cent. was out of the question, because the full strength produced bad results; a product was therefore used containing only 40 per cent. of pure potash, but the remaining 60 per cent. represented so much ballast, that the cost of freightage was more than doubled. The mixing of fertilising materials by the farmer himself, however, apart from the trouble involved, was often attended with danger, since mistakes and consequently unsatisfactory crops, could not always be avoided.

Nitrophoska J. G. has the advantages of a compound fertiliser without its drawbacks. Its synthesis is not mechanical; the mixing is done in such a way that it is to be regarded rather as a chemical process, and not as a mechanical mixture of the three ingredients. The proportions of the nutriment in it satisfy, in the demands of science and practice. And they vary according to the different kinds of soil, so that the new fertiliser is produced in different forms. For Germany, it is prepared in two forms; for heavier soils, Nitrophoska I.G.I., is used; for plants specially requiring potash, and for lighter soils, Nitrophoska I.G.II. Unlike most artificial fertilisers, which are mealy or powdery, and give off much dust, Nitrophoska is granular in form, and is thus more easily scattered. It is of white-grey colour, and entirely free from ingredients injurious to plants. As it is easily dissolved, the plants quickly absorb it.

The highly concentrated quality of the new fertiliser, and the ease with which it can be applied, make it probable that farmers all over the world will soon be using it. Not that it should supersede other fertilisere. The farmer will rightly not give up using the natural stable manure, which is so rich in bacteria, and so good for the soil. But he will also be glad to take advantage of the new compound fertiliser, which, in addition to its good qualities, will also guarantee a saving of expense and labour.

GAS *v.* ELECTRICITY.

Relative Merits of Rival Systems in Cooking and Heating.

The relative merits of gas and electricity in cooking and room-heating were the main theme of an interesting address by Dr. Harold Hartley, Chief Chemist to the Radiation Laboratories on Friday, April 1, at a conference of the British Commercial Gas Association held at Wallasey, Cheshire. He claimed for the gas fire, as compared with the electric heater, the following three distinct advantages :—

(1) It ventilated the apartment.
(2) It was odourless (with the electrical heater there was always present the peculiar odour characteristic of burning dust).
(3) It was economical to operate.

"With gas at eightpence a therm, and electricity at a penny per unit, heating with electric fires costs more than twice as much as with the gas fire," said Dr. Hartley. "For intermittent service the modern gas fire is cheaper also than the coal fire. Even for periods up to four hours consecutively it costs no more to heat a room by means of gas than it does with coal. The modern gas fire, which is so different from the earlier models, is silent in operation, heats by radiant energy, ventilates the room, and is hygienic, satisfying all the requirements which medical research has shown to be necessary for proper domestic heating."

Dealing with the question of cooking, Dr. Hartley declared that to-day it was almost as cheap to cook by gas as it was in 1914, owing to improvements made since the war in the design of the gas cooker. The gas oven had been completely modified; the flue outlet had been taken from the top to the bottom of the cooking space, and arrangements made to lead the products of combustion directly out at the bottom of the oven. As a consequence, the steam con-

tent of the cooking atmosphere was increased, thus ensuring better baked bread and better browned joints. With the most modern type of gas cooker it was possible for the housewife, after setting the "Regulo" in accordance with the instructions issued by the makers, to light the oven, insert the food and pay no further attention until the allotted time had passed, and on removing the food from the oven it would be found perfectly cooked.

Comparing the most efficient type of gas cooker with the most efficient electrical cooker, and assuming the fuel cost to be eightpence per therm for gas and a penny per unit for electricity, a prolonged series of tests had yielded results which showed that electricity cost 2.2 times as much as gas for cake baking; 3.0 times as much for mutton roasting; 4.1 times as much for bread baking, and from 2.8 to 3.3 times as much in the cooking of typical menus. With regard to the quality of the cooking there was nothing to choose between the results attained with either type of oven, provided care was taken with the electrical cooker to ensure that the interior of the food was properly cooked.

Dr. Hartley stated that unless the electrical undertakings could supply energy at a cost per unit which was only one-twenty-fourth that of the cost of gas per therm, then cooking by electricity would remain dearer than cooking by gas.

General Notes.

CANADIAN PROSPERITY.

During the last two years (says the Royal Bank of Canada), Canadian agriculture, mining, fishing, manufacture and transportation have been experiencing a fundamental prosperity which indicates an insistent world demand for the varied products of Canadian industries. That a country with a population of less than ten million people should have exported $1,271,000,000 worth of goods in 1925 and $1,269,000,000 worth in 1926 implies a tremendous productivity per capita. Canada is now the leader in the production of newsprint, asbestos, nickel, cobalt and salmon, and produces the world's largest exportable wheat surplus.

This rapid development of the natural resources of the country is attracting widespread investment interest and has resulted in the investment of about five and a half billion dollars from foreign sources. Of this amount, about three billion has come from the United States and two billion from Great Britain. The major items of British investment have been public, railway, mortgage, banking and insurance securities; while a large proportion of money from the United States has been invested in mining, forestry and manufacturing.

In 1925, the products of Canadian mines had a value of two hundred and twenty-five million dollars; in 1926, the value aggregated two hundred and forty-two million dollars—a new record.

MINERAL OIL REFINING IN GREAT BRITAIN.

Although the refining of oil produced by retorting Scottish shale has been carried on for many years, the refining of crude petroleum (all of which, except a trifling amount from one well in Derbyshire, has to be imported) has only recently become of importance in this countdy. The growth of the industry in recent years is indicated by the figures of imports of crude petroleum, which from one million gallons in 1913, 7½ million gallons in 1919, and 4 million gallons in 1920 rose suddenly in 1921 to 101 million gallons (of which 90 million gallons were from Persia) and increased steadily to 569 million gallons in 1925, falling back slightly to 539 million gallons in 1926. Approximately, 1½ per cent. of the world's production in 1926 was refined in Great Britain. The chief sources of the crude petroleum imported in 1926 were Persia (419 million gallons, as compared with 381 in 1925), Venezuela (64 million gallons, as compared with 151 in 1925), Mexico (38 million gallons, as compared with 27 in 1925), Columbia (7½ million gallons), and the United States (5½ million gallons). British countries (Trinidad and Sarawak) contributed a little over 2 million gallons.

METHODS OF ANALYSIS OF COAL.

A report on the methods of analysis of coal has just been published for the Department of Scientific and Industrial Research by H.M. Stationery Office (price 9d. net). It is the seventh of the series of reports on matters connected with the Physical and Chemical Survey of the National Coal Resources, and supersedes Survey Paper No.

2, " Interim Report on Methods of Analysis of Coal."

The Report has been prepared by the Sampling and Analysis of Coal Committee of the Fuel Research Board, and the methods described have been adopted by the Department of Scientific and Industrial Research for the purposes of its work on coal.

The methods recommended are the result of extensive investigations carried out by the members of the Committee in their own laboratories. A number of changes have been made in the methods given in the Interim Report mentioned above, and these have been incorporated in the Revised Report, which is now published for general information.

COMMITTEE ON VISUAL AIDS TO CHEMICAL INSTRUCTION.

Division of Chemical Education, American Chemical Society.

At the Philadelphia meeting of the Division of Chemical Education, the above committee was authorised to send out a long questionnaire. Its purpose is to collect information from which an average viewpoint may be obtained as to visual aids in chemical instruction.

An accompanying letter says : —

" The committee earnestly solicit your co-operation in this important step in their work which they hope will be of great service to those teaching chemistry. As it is desired to summarise the data obtained and base future action an such a recapitulation prior to the Richmond meeting, the immediate return of the questionnaire, properly filled out, will be greatly appreciated.

If you have the time to relate your experiences or thoughts on this subject beyond the opportunities afforded in the form, please do so. We want your comments."

For the purposes of this questionnaire, visual aids are limited to : 1, opaque photographs; 2, lantern slides; 3, film slides; 4, motion pictures; and 5, animated drawings by means of motion picture equipment. In answering it will be convenient to use the numbers just given each type of material. Return questionnaire immediately, whether you can answer all questions or not."

Information is desired on the status of the educational institutions, the number of pupils, the number studying chemistry, whether money is available for visual aids, what visual aids, if any, are used; would the institution be prepared to purchase suitable films, and how much per year would be available ;several questions applicable to chemistry. The replies are to be sent to Mr. Felix A. Elliott, 343, State Street, Rochester, New York, U.S.A.

AVERAGE VALUES OF FARM POULTRY IN CANADA, 1926.

The average values per head for Canada for each description of farm poultry are estimated by the Dominion Bureau of Statistics at Ottawa as follows : turkeys, \$2.94; geese \$2.15; ducks \$1.14; other fowls 90 cents. For the whole of Canada the numbers and values of farm poultry in 1926 are accordingly estimated as follows : turkeys—No. 2,147,814; value \$6,313,000; geese—No. 1,166,030; value \$2,608,000; ducks—No. 1,073,079; value \$1,221,000; other fowls — No. 45,254,549; value \$40,928,000; total poultry—No. 49,641,472, value \$50,971,000.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

April 7.

Trypanocidal Action and Chemical Constitution. Part VI. Amphoteric s-*Carbamidoarylarsinic Acids.* By H. King.

Some *s*-carbamidoarsinic acids with a free basic centre have been prepared and examined for trypanocidal activity. A study has also been made of the nitration of *o*-aminophenal derivatives.

On Active Nitrogen. Part III. Active Nitrogen and the Metals. By E. J. B. Willey.

In Part I and II experiments were described in which it was shown, on the assumption that the active nitrogen content of a gas mixture could be evaluated by means of the reaction $N_2 + 2NO \rightarrow 2N_2 + O_2$, that the energy content of active nitrogen was of the order of 2.0 volts. By

passing active nitrogen over thin metallic spirals of various metals, it is shown that the metals vary in their powers of effecting the catalytic decomposition of active nitrogen. This variation is attributed to the difference in the stability of the nitrides of the metals. Copper is active at the ordinary temperature, platinum and zinc at somewhat elevated temperatures. The nitrides of molybdenum and tungsten are too stable to effect catalytic decomposition of active nitrogen even at high temperatures. From the rise in temperature of the spirals for different flow speeds of active nitrogen the energy content of the latter has been determined, and shown to agree with the values obtained previously, *viz.*, 2 volts.

Esterification in Mixed Solvents. By B. V. Bhide and H. E. Watson.

The velocity constants for suberic and *n*-butyric acids in mixtures of *iso*amyl alcohol with benzene and petroleum have been measured using hydrochloric acid as catalyst; Goldschmidt and Udby's formula $(r - a) \log a/(a - x) - x = Kt$ gives satisfactory values. These constants increase very considerably with increase in the proportion of inert solvent, the values for 90 per cent. benzene and petroleum rising in a hyperbolic manner to approximately 14 and 20 times the value in the pure alcohol.

It is suggested that the velocity depends not on the concentration of catalyst in the whole solution, but on the ratio of catalyst to alcohol molecules. If this were so, the veloctiy consant for a 90 per cent. solution would be 10 times that calculated in the ordinary way. The additional rise observed is qualitatively explained by the relative increase in velocity which occurs on increasing the concentration of catalyst.

The results show that reaction can take place readily when very few ions are present in the solution.

An observed decrease in velocity constant for small additions of inert solvent and certain minima in the conductivity values have not yet been explained.

THE OPTICAL SOCIETY.

At the meeting of the Optical Society held at the Imperial College of Science and Technology on Thursday, April 7, the following communications were read and discussed :—

The Hartmann Formula for the Dispersion of Glass. By H. W. Lee, B.A. (Messrs. Taylor, Taylor and Hobson, Ltd.).

The Hartmann formula is found to be accurate within the limits of the Pulfrich refractometer. A number of glasses are graphed from their Hartmann constants, and it is seen that optical glasses can be divided into three well-marked classes, with linear relations between the constants in each class.

Huygens' Principle and the Phenomena of Total Reflexion. By Prof. C. V. Raman, F.R.S. (The University, Calcutta).

In this paper the phenomena of total reflexion are considered, *de novo*, from the standpoint of the Principle of Huygens, no use whatever being made of the Fresnel formulæ for reflexion and refraction. Huygens' principle enables us to evaluate the disturbance appearing in the second medium when light is incident on the boundary between two media and is totally reflected into the first medium. The disturbance takes the form of a superficial wave moving parallel to the boundary. The existence of such a superficial wave is then shown to involve, as a necessary consequence, an acceleration of the reflected wave with reference to the incident wave, the acceleration being zero at critical incidence and increasing to half an oscillation at grazing incidence. The intensity of the superficial wave is at critical incidence greater for the component having the magnetic vector parallel to the surface, but diminishes more rapidly with increasing incidence than for the component having the electric vector parallel to the surface; the phase-advance reaches its maximum value correspondingly sooner. The phase-angle between the two components is evaluated and found to be an acute angle, in agreement with the classical treatment based on the Fresnel formulaæ, but in disagreement with the conclusions of Lord Kelvin and Schuster. The source of error in the Kelvin-Schuster treatment is pointed out. Experimental evidence regarding the magnitude of the phase-advance of each component separately is available and is in agreement with the classical theory.

Finally a method is described by which the distribution of intensity, state of polarisation, and direction of flow of energy in the superficial wave may be studied experimentally.

SOCIETY OF PUBLIC ANALYSTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, April 6, Mr. John White, Vice-President, being in the chair.

Certificates were read for the first time in favour of Messrs. Frederick Cecil Bullock, B.Sc., A.I.C., Thomas Harold Fairbrother, M.Sc., F.I.C., Ralph Skinner Rack, and Samuel George Sherman.

Certificates were read for the second time in favour of Messrs. Alfred George James Lipscombe, B.Sc., A.I.C., William L. Matthews, Sydney John Rogers, B.Sc., F.I.C., Ernest Fred Waterhouse, Harold William Webb, Arthur Samuel Wood, M.Sc., Ph.D., F.I.C.

The following were elected members of the society :—William Gordon Carey, F.I.C., William Farrand Elvidge, B.Sc., A.I.C., Lewis Sidney Fraser, B.Sc., A.R.C.Sc., A.I.C., Frederick Percival Hornby, B.Sc., A.I.C., Gerald Roche Lynch, O.B.E., M.B., B.S., D.P.H., Eric C. Martin, and George Gilmour Philip.

The following papers were read and discussed :—

The Sequence of Strokes in Writing. By C. Ainsworth Mitchell, M.A., F.I.C., and T. J. Ward.

Systematic experiments have been made to determine to what extent one may trust to the appearance of one of two intersecting lines being uppermost as a proof that it was made more recently than the other. It is shown that the appearance coincides with the fact in the case of insoluble opaque pigments such as lead pencil, but is deceptive when a transparent pigment such as an aniline dye is in question. The relative position of lines made with writing inks which undergo oxidation, and thus form an opaque insoluble pigment, can usually be accurately determined, but if the ink has been blotted the observation is, as a rule, untrustworthy.

Observations on the Washing of Gluten from Flour. By D. W. Kent-Jones, Ph.D., B.Sc., F.I.C., and C. W. Herd, B.Sc., F.I.C.

It is shown that the use of a special washing solution, such as that suggested by Dill and Alsberg, does not eliminate the errors inherent in gluten determinations. Even when the same amount of washing water is used and the same procedure followed, personal differences in the manipulation of the dough and gluten cause large variations in the result. It has been found, however, that each operator gets essentially consistent results, which means that the ratio between the nitrogen of the flour and the dried gluten is approximately constant for each worker.

A Numerical Expression for the Colour of Flour By D. W. Kent-Jones, Ph.D., B.Sc., F.I.C., and C. W. Herd, B.Sc., F.I.C.

The colour of flour may be expressed by the tints given to two distinct solvents. The yellow colouring matter is extracted by means of petroleum spirit, and its colour is measured in a special form of colorimeter. This figure indicates the natural whiteness, or alternatively, the artificial bleaching of the flour. The grade of the flour may be judged by the amount of the reddish-brown pigment present which, presumably, comes from the finely powdered offal present. This pigment is determined in the colorimeter after extraction with alkaline methyl alcohol.

The Determination of Free Mercury in Commercial Products. By H. B. Dunnicliff, M.A., Sc.D., F.I.C., and Kishen Lal, M.Sc.

The main constituents of the substance containing free mercury are removed by extraction with a suitable solvent. The residue is treated with bromine water, the resulting mercuric bromide is dissolved in alcohol, and the mercury is precipitated as mercuric sulphide, which is filtered off and weighed in a Gooch crucible. The method is shown to give accurate results with various commercial products, such as mercury ointment, grey powder and mercury fulminate.

INSTITUTION OF ELECTRICAL ENGINEERS.

Illuminating Engineering. By John W. T. Walsh, M.A., M.Sc., Associate Member.

Summary.

The wide range of subjects, physics and engineering, physiology and psychology, coming within the purview of the illuminating engineer is pointed out. A brief *résumé of the recent rapid progress in* illumination is followed by a description of fundamental principles; in particular the

use of the modern conception of luminous flux in illumination calculations is described.

The chief requirements of a lighting system are that the lighting should be both adequate and suitable. It is pointed out that in the past adequacy has generally been emphasised to the neglect of suitability. It is, however, difficult to over-estimate the importance of the latter factor in good lighting and it is dealt with in some detail under the following headings :—

(a) Freedom from glare and excessive contrast in the field of view;
(*b*) Adequate but not excessive diffusion;
(*c*) Correct colour;
(*d*) Correct proportion of local and general lighting.

As an example of the application of the results of a psychological investigation to a practical lighting problem, a description is given of a method of so designing a street-lighting system that the glare may not exceed a certain specified limit.

In conclusion the opinion is expressed that the present lighting load could be at least quardupled, with immense benefit to the community.

Introduction.

Illuminating engineering may be defined as that branch of applied science which deals with the generation, distribution and use of visible radiation.

The first division of the subject demands of the illuminating engineer a knowledge of general physics, particularly as regards radiation, and it is clear that in all cases where electric lighting is concerned a training in electrical engineering is equally essential.

The distribution of light is the most specialised part of the subject, dealing, as it does, with such matters as the design of reflectors and fittings and the planning of installations to give a predetermined illumination.

The last division of the subject is by far the most complex of the three, and it is here that illuminating engineering differs most from other branches of applied science. For light can be used only by the eye. The eye, therefore,, is the final judge of the performance of any lighting system. The illuminating engineer must keep constantly before him the fact that the true appraiser of his efforts is the human eye. He must carefully study the eye, its likes and dislikes, its behaviour under all varieties of lighting conditions, its response to all degrees of stimulation, the extent of its variation from one individual to another, and the effect upon it of such external factors as age, refractive errors and others over which he can have not the slightest control. In other words, the true illuminating engineer must have a good working knowledge of physiology and psychology, at least as far as they deal with this particular one of the special senses.

This apparently exacting demand is, when rightly appreciated, one of the chief attractions of the subject. The student who takes up the study of illumination is probably brought into touch with a wider range of subjects than is the case in any other branch of engineering. He has to learn from the architect, the ophthalmologist and the psychologist—particularly the industrial psychologist—as well as the engineers dealing with the different sources of power which are employed for lighting at the present time, and it is the purpose of the present paper to show, as far as possible within a limited space, the manner in which the three great subjects of engineering, physiology and psychology have to be combined in the practice of the modern illuminating engineer.

First, however, it may not be altogether out of place to give a brief historical survey of the subject and to review its remarkably rapid development within the last two decades.

Historical.

It is interesting to notice that the pioneer work in illumination was done in this country some 40 years ago by a past-president of this Institution. Mr. A. P. Trotter tells in his book how he was associated with Sir William Preece in what was probably the earliest set of illumination measure ments ever made. The instrument used for the purpose has been described in many places and was the precursor of what is now universally known as the Trotter photometer. There is little doubt that it was the first instrument ever designed for the special purpose of measuring illumination, although shortly afterwards portable photometers, originally designed for the measurement of candle-power, were adapted to measure illumination as well.

The first paper dealing specifically with what is now known as illuminating engineering was read by Mr. Trotter before the Institution of Civil Engineers in 1892. Since that time the subject has progressed with an apparently ever-increasing rapidity. The early years of the present century witnessed the formation of technical societies to foster

the progress of illuminating engineering both nationally and internationally. The first national body of this kind to be formed in Europe was the Illuminating Engineering Society founded in this country in 1909. The international body was formed in 1913 by enlarging the scope of the already existing International Photometric Commission so as to embrace the whole subject of illumination in all its aspects.

CONCLUSION.

Finally, it may not be out of place here to add a few words on the bearing of lighting progress on the electrical industry in general. Lighting has developed with great rapidity during the last decade. It is destined to develop still further during the years to come. The opinion has been expressed that many modern lighting installations providing an illumination of 3 or 5 foot-candles represent the saturation point, at least as far as load is concerned. The author does not agree. Far higher degrees of illumination will be found advantageous so long as proper care is taken to ensure that the light provided is used in the right way.

It may well be that a proper distribution of the light provided, or a desirable modification of its spectral distribution, may result in a utilisation factor far lower than that commonly attained at the present time. Such an apparently wasteful system may, in reality, be the best when the psychological factors are given due weight in the problem, and there is every indication that the economic value of good lighting is such that even a large increase in lighting costs may be far outweighed by the benefits resulting from increased economic efficiency. It is not too much to say that 90 per cent. of people in this country carry on their work after daylight hours by an inadequate illumination and an unsuitable system of lighting. A quadrupled lighting load, properly employed, would result in better health, physically and mentally, and its cost would be trifling compared with the benefits it would confer on every class of the community.

THE PHYSICAL SOCIETY.

At the meeting held on Friday, Mar 11, at the Imperial College of Science, Prof. O. W. Richardson, M.A., D.Sc., F.R.S., in the chair, the following papers were read :—

Measurements of Absorption Coefficients of Light Filters. By G. M. B. DOBSON, D.Sc., AND I. O. GRIFFITH, M.A., Clarendon Laboratory, Oxford, was taken as read in the absence of the authors.

ABSTRACT.

A new spectro-photographic method of measuring absorption coefficients is described. A portion of the slit of a spectograph is covered by the absorbing medium, and in front of the photographic plate or of the slit a neutral wedge is placed. The resulting spectogram consists of two parts, one due to light which has passed through the fiilter and the wedge, the other to light which has traversed the wedge only. It is shown how from a knowledge of the distance between two points, one in each part of the spectogram, which are of the same density, the absorption coefficient of the filter at any wavelength may be determined. The source of light need not be constant.

A Comparison of the Behaviour in Thermal Diffusion of Nitrogen and Carbon Monoxide, and of Nitrous Oxide and Carbon Dioxide. By T. L. IBBS, M.C., Ph.D., Lecturer in Physics, AND L. UNDERWOOD, M.Sc., University Research Scholar, University of Birmingham. Read by Dr. Ibbs.

ABSTRACT.

The thermal separation obtained in gas mixtures containing nitrogen is compared with that obtained in mixtures containing carbon monoxide. A similar comparison is made of mixtures containing carbon dioxide or nitrous oxide. The gas analysis required in the measurement of the effect is made by means of the Shakespeare katharometer. The behaviour of nitrogen is found to be similar to that of carbon monoxide. The effect given by carbon dioxide is generally a little greater than that given by nitrous oxide.

The pairs of gases examined provide a special case for the application of the Enskog-Chapman theory, as in each pair the molecular weights and mean collision areas are the same. It can thus be deduced that the molecular field of nitrogen is similar to that of carbon monoxide, and that the field of carbon dioxide differs little from that of nitrous oxide.

DISCUSSION.

Professor S. Chapman said that the molecular similarity of the gases discussed, which had already been shown by Rankine and Smith, was still more directly proved by the present method. Thermal diffusion

is a phenomenon discovered by means of mathematical analysis, and it is very difficult to form any physical picture of the way in which it arises : wherever a temperature gradient exists in a mixture of gases, a separation of the components takes place until equilibrium with the mixing effect of ordinary diffusion is established. The phenomenon disappears when the attraction between molecules varies as r^{-5}, and its magnitude affords a measure of $(n-5)$ when the attraction varies as r^{-n} Every point on the curves obtained by the authors gives a measure of n, whereas in the viscosity experiments n has to be inferred from the viscosity at two temperatures, from the formula $\log v = [(n-1)/2(n-3)] \log T$, where v is the viscosity and T the temperature. Further, the coefficient of $\log T$ is not very sensitive to variations of n, so that the present method affords a far more delicate measure. On the assumption that n is 2 in stars where ionisation is complete, the quantity $(n-5)$ would be negative, and the effect of thermal diffusion would be reversed in sign, the heavier molecules moving towards the higher temperature.

Relighting of a Neon Lamp when Momentarily Extinguished at Voltages Below the Striking Potential. Read by ROBERT R. NIMMO, M.Sc., Assistant Professor of Physics, University of Otago, Dunedin, New Zealand.

ABSTRACT.

The paper gives an account of an investigation on the time for which the continuous discharge of a neon lamp may be interrupted without putting out the lamp. This time which has been found to be of the order of 50 micro-seconds, depends on the voltage across the lamp and also on the current passing through it.

DISCUSSION.

Mr. A. G. Tarrant said that he and Mr. Oschwald had recently measured not only the minimum time of interruption, but the actual voltage at relighting for interruptions down to 3 micro-seconds, and had found no case where lighting took place below the upper critical voltage. He suggested that in the author's apparatus surges of current may take place, owing to the presence of inductance in instruments and leads, and so raise the starting voltage above the applied D.C. voltage. This view was consistent with the effect of varying R as found by the author. Further, the author deduced the duration of the interruption from an expression involving the difference between two large voltages not accurately known. It would be of interest for the author and the speaker to experiment on one another's lamps ,in order to eliminate divergences of result due to differences between the lamps.

Electricity of Dust Clouds. By G. B. DEODHAR, M.Sc., Physics Department, University of Allahabad (India), was taken as read in the absence of the author.

ABSTRACT.

1. Observations on electrification of various dusts have been made by using a large volume of air at a pretty high speed. The climatic conditions are totally different from those under which similar observations were previously made.

2. The number of substances tried is considerably increased. In some cases the sign of electrification observed agrees with that found by Rudge.

3. The factors governing the phenomena of electricity of dust storms are stated as follows : (1) Material of the dust. (2) Its size. (3) The gas raising the cloud. (4) The velocity of the gas. (5) The temperature. Account of the first two factors is given in the present communication.

4. It appears that the electricity developed is of frictional nature, which itself is, of course, unknown.

5. Some quantitative estimates of electrification of chlorides and nitrates of sodium and potassium are made. It is seen that chlorides of sodium and potassium are equally efficacious, whilst sodium nitrate is about $4\frac{1}{2}$ times as efficacious as potassium nitrate.

6. Dusts of various roughly uniform sizes were obtained with the help of a few graded sieves. The magnitudes of the various sizes were obtained after very laborious observations under microscope. It is shown graphically that, other things being the same, the number of volts developed by blowing increases very rapidly as the size grows less.

DISCUSSION.

Dr. P. E. Shaw (communicated) : These experiments by Mr. Deodhar, and the well-known earlier ones by Mr. Rudge, have special interest for me, as I have recently sent a paper bearing on this topic to the Society. The effects, however, which I obtain are due to the impact of only two like bodies, and in this way the condition of the impacting surfaces can be ascertained and varied at will. The dust cloud experiments are interesting, as they are closely analogous to the natural phenomena found in the air under dry, tropical condi-

tions; but one may doubt if they are not altogether too comple xto yield a solution of the problems involved. For instance, in these dust impacts the particles strike one another at all possible angles, and with a great range of speed. Such variable cannot be ignored. The curvature of the striking surfaces must be very varied, and with the varied curvatures there will be different conditions of their adsorbed layers. Also, among the variables mentioned by Mr. Deodhar in the first clause of his paper, the hygrometric state is not mentioned, though it is well konwn that moisture plays a veiy important role in tribo-electric effects.

Then ,again, the charges observed in the apparatus shown are compounded, in unknown relation, of four parts :—

(1) Net charge, say *-ve* left on the impacting particles; (2) the contrary, say *+ve*, and equal, charge on the ions emitted to the air; (3) charges of unknown sign and amount, due to impact of the particles on the walls and gauze of the chamber; (4) ions corresponding to these, emitted to the air.

True, a net charge from all these remains in the chamber, and is recorded on the electrometer when the air has been blown through it; but how is it possible to disentangle the effects and eliminate those due to the chamber itself?

Without anticipating the results of my own paper, I may say that the electrical nature of surfaces may change fundamentally when rubbed or struck, so that it is possible to obtain a *+ve* or *-ve* charge at will from like solids. In a dust cloud we may expect some impacts to yield net *-ve*, some net *+ve*.

When the particles are very small, then, for the same total mass in a cloud, there would be correspondingly more contacts and greater charges, as Mr. Deodhar finds.

CELLULOSE INDUSTRY IN JAPAN.

By Katsumoto Atsuki.

(From the Journal of the Society of Chemical Industry, Japan.)

The cellulose industry, including the manufacture of pulp, paper, artificial silk and celluloid is very prosperous in Japan.

Pulp and paper.— The home production of wood pup in 1925 is estimated at 420,000 tons and there was an importation of 470,000 tons. The production of sulphite pulp is estimated at about 300,000 tons in 1925 including all grades from the strong to the easy bleaching. The silk pulp for artificial silk has not been produced because of its small consumption. It is expected, however, to be produced in the near future as the demand rapidly increases. As the pulp wood are used the Japanese spruces, Picia ajensis and Abies saccharinensis, grown in abundance in Hokkaido and Karafuto.

Nearly all the kinds of papers of European style are manufactured in Japan, except those special ones which are not used in a large quantity. The Japanese papers are very strong, durable and suitable for making tracing and copying papers. They have been made by hand from the bast fibres of Gampi, Mitsumata and Kozo by digestion with wood ashes or lime and beating by stamping in a wet state, but are now manufactured more and more by paper machineries. If the original primitive process is replaced more completely by the introduction of machinery, and the cost of production is cut down by the selection of raw materials and the adoption of scientific management, the industry of Japanese paper will become very important.

Artificial Silk.—The artificial silk industry is now very popular in Japan. Two large factories, the Teikoku Zinzo Kenshi Co. (Imperial Artificial Silk Co.) and the Asahi Kenshoku Co. (Sunshine Silk Weaving Co.) have been working to their full capacities and produced about 3,700,000 kg. in 1926. Three more large factories are under construction, and after their completion, the total home production together with the increasing output of the above-named two will be 6,000,000 kg. in 1927, 17,600,000 kg. in 1928 and 37,500,000 kg. in 1930. All of them use viscose process. The Teikoku Zinzo Kenshi Co., erected in 1914 has been working by a special viscose process of Mr. Itsuzo Hata, now managing director of the company. The artificial silk made in Japan is of good quality, and is used alone, or in admixture, with the real silk in making Kimono and Obi. The use of the artificial silk in the Japanese textiles is expected to increase more and more.

It is now generally considered that the real silk does not suffer any menace from the artificial silk, though the future situation of the competition is looked upon with much interest. As to the raw materials, Japan is fortunate in having rich forests of the pulp wood and an abundant supply of pure caustic coda. Unfortunately, however, some quantity of sulphur must be imported. The researches on viscose and the

artificial silk in general are very active, in the laboratories of the Universities, Institutions and Factories. Japan is very anxious to achieve success in the economical manufacture of artificial cotton.

Celluloid.—Japan is very proud of having a large celluloid company, the Dai Nippon Celluloid Co., with its three large factories, well equipped with modern machinery, having a capacity of about 6,000,000 kg. of celluloid yearly. There are several small plants besides. The cellulose material now used is a fine cotton tissue paper, though the purified sulphite pulp in form of crepe tissue paper can be profitably used for some kind of celluloid. The nitration is carried out in a number of pots arranged in a circle on a revolving table. The celluloid for making toys is always in great demand. Such celluloid must be highly plastic and lustrous, and is prepared by the use of a cellulose nitrate of a low viscosity with a large amount of camphor. The celluloid of a high elasticity enjoys also a large demand as material for massive toilet goods, and in this case a cellulose nitrate of a high viscosity is used. It is reported often that the synthetic camphor will replace the natural camphor. There is however good reason to believe that the natural camphor can be produced at a much reduced cost by adopting a reasonable means in cultivation and extraction. So long as the synthetic camphor is produced from turpentine the natural camphor will not be menaced easily.

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

Wednesday, April 27, at 8 p.m.—(Ordinary Meeting.) G. E. Keay, F.C.I.I. (of the Norwich Union Fire Insurance Society, Ltd.): " Fire Waste (Loss of Property by Fire), and its Effects on the Economics of National Life in Great Britain." (Fothergill Prize Essay.) Rear-Admiral James de Courvy Hamilton, M.V.O., Member of the Council of the Society, and Chief Officer of the London Fire Brigade, 1903-1909, will preside.

SOCIETY OF GLASS TECHNOLOGY.

The Tenth Annual General Meeting will be held in the Applied Science Department, The University, St. George's Square, Sheffield, on Wednesday, April 27, 1927, at 2.30 p.m. There will be a General Discussion on Furnace Efficiency, introduced by " A Brief Review of Furnace Developments," by Prof. W. E .S. Turner.

Arrangements have been made for members to have lunch together at the King's Head Hotel, Change Alley, High Street, Sheffield, at 1 p.m., on Wednesday, April 27, 1927. Charge, 3s. 6d. each, payable at the Hotel.

A short discussion will take place after luncheon on the proposed Glass Convention.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the *Official Journal of Patents,* and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

8,789.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of new compounds of thiazole series. March 30th.

8,640.—Cerini, L.—Purification of caustic soda, etc. March 28th.

8,894.—Colombo, M. — Chambers for manufacture of sulphuric acid. March 31st.

8,685.—Holliday & Co., Ltd., L. B.—Production of dyestuffs. March 30th.

8,607.—Kaiser, L.—Manufacturing finely-distribtued sulphate of barium, etc. March 29th.

Specifications Published.

267,996.—Lambert, A.—Processes for the manufacture of potassium nitrate.

268,158.—Tcherniac, J.—Separation and purification of vanillin.

268,181.—A.P.I.C.E. Soc. Anon, Prodotto Italiani Chimici Estrattivi and Gasparrani, O.—Manufacture of sodium chloride.

265,540.—Rhenania Verein Chemischer Fabriken Akt.-Ges. — Manufacture of moulded sulphur.

245,152.—Deutsche Gold -Und Silber-Scheideanstalt Vorm Roessler.—Process for the production of concentrated solutions of alkali cyanides.

Abstract Published.

265,639.—Alkali cyanides.—Deutsche Gold- Und Silber - Scheideanstalt Vorm Roessler and Freudenberg, H., 7, *Weissfrauenstrasse*, *Frankfort-on-Main*, Germany.

Alkali cyanides; ammonia; hydrogen.—In the production of alkali cyanides by the reaction of ammonia on a mixture of an alkali metal and carbon, the hydrogen evolved is purified, for instance by washing with water and drying with lime, and is used with nitrogen for the known ammonia synthesis with the aid of pressure and a catalyst. The ammonia is then used again for the production of the cyanide.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

SHUR-OFF.

478,067.—Chemical substances prepared for use in medicine and pharmacy.—Milan Francis Pratt, The Factory, Braydon Road, London, N.16. April 6th.

PA-PYTA.

477,668.—Chemical substances prepared for use in medicine and pharmacy.—The Anglo-French Drug Company, Limited, 238a, Gray's Inn Road, London, W.C.1. April 6th.

SVEDOCAIN.

477,136.—Chemical substances prepared for use in medicine and pharmacy.—Aktiebolaget Chemia, Hamngatan 2, Stockholm, Sweden. April 6th.

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THE PREPARATION AND SOME CHEMICAL PROPERTIES OF RHENIUM (DVI-MANGANESE).

By W. AND I. NODDACK (Berlin).

(Abstracted from *Zeitschrift fur physikalisshe Chemie*, 1927 CXXV., 264.)

[EDITORIAL NOTE.—As readers of the *Chemical News* are aware, this Journal has been the medium for the announcement to the scientific public of important discoveries in connection with the Chemical Elements. A glance through the *General Index* to the first 100 Volumes, and later Indexes, will indicate that discoveries of this kind were published by the *Chemical News.*]

The problem of the two missing homologues of manganese has occupied the attention of investigators ever since the enunciation of the Periodic Law in 1869. Both physical and chemical methods have been used with the object of finding these elements.

In June, 1925, with the collaboration of O. Berg, we described the detection of eka- and dvi-manganese, giving a forecast of their chemical and physical properties.

We assumed that they occurred to a much less extent than their neighbours, ruthenium and osmium. From this we proceeded to enrichments from a large number of minerals, *e.g.*, platinum ores, which gave *the hitherto unknown voatile oxide of 75.* By systematic enrichment from columbite and gadolinite we obtained preparations which showed with certainty the presence of 43 and 75. Half a year later several workers claimed to have discovered element 75 in manganese. Since then many papers have appeared on this subject. We have in the meanwhile concerned ourselves with 75 because our early work has been questioned, but no one else has worked on masurium (43).

Geochemistry of Rhenium.—This prognosis constitutes an important factor in the discovery of 75. This element would form oxides : Re_2O_7, ReO_3, and Re_2O_5. The first oxide giving a very weak acid, H_2ReO_6, since this oxide falls between OsO_4 and WO_3. In the earth's crystallisation it might be present in a form in which it had displaced Mo and W in the very difficultly soluble salts of the type $X''ReO_4$ (*e.g.*, $CuReO_4$) and by partly displacing Nb and Ta as $X''(ReO_3)_2$. These would appear in the end crystallisations.

By volatilisation at 1500-2000° C., the oxides of Ru and Os were dissociated, but the Mn homologues would be less so, and by this process we reached a probable concentration of about 10^{-4} for the manganese homologues in platinum ores.

The Process of Enrichment.—This followed our forecast of the chemical properties. The higher oxide of rhenium could be separated from most other oxides by its solubility in mineral acids. Its sulphide, however, is insoluble and here seemed a mode of separation.

Other sources, *e.g.*, osmiridium, were first subjected to alkali fusion. Molybdenum ores were first reduced in a stream of hydrogen. Tungsten ores were also fused with alkalis and then their solution acidified to remove tungstic acid.

The chief source was columbite. One to twenty kilograms of this were heated many hours with twice as much by weight of NaOH and 5 per cent. $NaNO_3$. The cooled product was exposed to air for many days and then shaken up with water to yield a 5 per cent. alkali solution. After standing, the liquid was filtered and the residue

washed with 5 per cent NaOH. This dissolved a minimum of Nb and Ta. The green filtrate contained manganites and was treated with hydrogen peroxide to precipitate $MnO_2.H_2O$; and with 5 per cent. ammonium chloride which precipitated the earthy acids and Si, Ti, Nb, Ta. The resulting filtrate of 300 litres was weakly acidified with sulphuric acid and the nitrous acid removed. A small precipitate of Ti and Pb and a little Si, Nb, Zr, Ta, Hf, but no Re came down.

Sulphuretted hydrogen was passed in till the solution was saturated with the gas. The sulphide precipitate was filtered off and the filtrate was treated with ammonium hydroxide and ammonium sulphide and re-acidified to 5 per cent. HCl. These sulphides were united to the first precipitate and were heated in a stream of hydrogen to remove sulphur. The residue contained

	%
Nb + Ta	40
Si	5
Ti + Zr + Hf	5
Fe + Co + Ni + Mn	10
W + Mo + Sn + V	30
Cu + Pb + As + Sb + Bi + Pt + Ge + Zn + Cd	10

Traces of Ir, Ru and Os

These sulphides were warmed with dilute *aque regia* and the sulphur and tungstic acid were filtered off. The filtrate was evaporated to drive off the HNO_3. On reduction of the residue in hydrogen there remained about one gram of substance containing

	%
Vanadium	15
Molybdenum	7
Tungsten	3
Platinum	10
Lead	5
Arsenic	15
Copper	15
Sn + Ge + Sb + Bi	20
Co and Ni	5
Nb + Ti + Ta	5
Re	0.2

Rhenium was identified by the distinct $L\alpha_I$ line.

This residue was treated like the osmiridium and wolfram ores, and the alkali fusion products were treated with ammonium chloride. Concentrated sulphuric acid was added to the filtrate and this was again filtered. This left Co, Ni, Cu, Pt, Bi, Nb, Ta, Sn, Ge, Sb; Pb, W and much V remained behind. A further hydrogen-sulphide precipitation gave a preparation (0.1 gr.) containing V 20 per cent., Mo 70 per cent, As 5 per cent, Nb + Sn + Sb 3 per cent., and Re 2 per cent.

When this was dissolved in *aqua regia* and filtered and freed from HNO_3 and made 5 per cent. acid and rapidly saturated with H_2S most of the molybdenum was precipitated as MoS_3. This precipitate contained only a trace of rhenium. The filtrate was made alkaline with ammonium hydroxide and ammonium sulphide was added to precipitate V, Mo, As and all the rhenium, whilst Sb and Sn remained in solution. This sulphide (15-20 mg.) was composed of V, 85 per cent., Re 10 per cent., Mo 3 per cent., and As 2 per cent.

The final treatment consisted in heating the reduced substance in oxygen. Most of the rhenium was driven off as a white oxide, which sublimed on the cool parts of the tube and was extracted by cutting the tube.

Gadolinite and other rare-earth minerals — monazite, cerite, orthite, malakon, zirkon, alvite, thorite and orangite— were treated in a similar manner.

Chemical Properties of Rhenium.—On heating the sulphide in a stream of hydrogen it gave a black powder, either the metal or a lower sulphide. This burned in oxygen on warming to an oxide which sublimed as a white powder, more volatile than MoO_3.

Hydrogen sulphide converted it into a grey sulphide which reformed the oxide on heating.

A trace of the oxide mixed with nickel powder gave the $L\alpha_I$, $L\alpha_2$, $L\beta_1$, $L\beta_2$, $L\beta_3$ and $L\beta_4$ lines of 75.

The oxide was soluble in a little dilute HCl to a colourless solution. There was no precipitate on adding, NaOH, KOH, or NH_4OH. H_2S gave no precipitate in the cold and only a slight cloudiness on warming. Addition of NH_4OH and $(NH_4)_2S$ caused no change. Acidifying this gave a grey precipitate soluble in ammonium sulphide with difficulty.

The spark spectrum as given between carbon electrodes gave a series of new lines the wave-lengths of which will be described subsequently. The small amount of the new substance (about 2 mg.) was enough to serve to identify the element by its X-ray and spark spectra.

We are at present engaged on the working up of minerals estimated to yield 30-50 mg. of rhenium.

The Editor of the *Chemical News* has kindly shown me the above abstract he has made of Drs. W. and I. Noddack's paper. It is an occasion to congratulate these eminent workers, for they have evidently obtained about 2 mg. of moderately pure rhenium, and we await with interest a published X-ray spectrum free from elements of contention as hitherto.

F. H. L.

THE CONDENSATION OF PHENOLIC ALDEHYDES AND THEIR ETHERS WITH METHYL ETHYL KETONE.

By Kenji Iwamoto.

(*Tokyo Imperial University.*)

Harries and Müller showed that, in the presence of an alkali, methyl ethyl ketone condenses with benzaldehyde to form the α-benzylidene derivative, $C_6H_5CH : CHCOC_2H_5$, and, in the presence of hydrochloric acid, to form the γ-benzylidene derivative, $C_6H_5CH :C(CH_3)COCH_3$.

Ichikawa reported that methyl ethyl ketone condenses with vanillin in the presence of an alkali, to yield 3-methoxy-4-hydroxystyryl ethyl ketone, $C_6H_3(OH)(OCH_3)CH :CHCOC_2H_5$, and, in the presence of hydrochloric acid, to give rise to the bimolecular compound, $C_6H_3(OH)(OCH_3)CH :CHCOC(CH_3) : CHC_6H_3(OH)(OCH_3)$. Claisen and Claparède found that in the presence of hydrochloric acid, benzaldehyde condenses with acetone to form dibenzylidene acetone, $C_6H_5CH :CHCOCH : CHC_6H_5$, and Nomura and Hotta observed that divanillylidene acetone, $C_6H_3(OH)(OCH_3)CH :CHCOCH : CHC_6H_3(OH)OCH_3)$, was formed by the condensation of vanillin with acetone in the presence of concentrated hydrochloric acid.

From these results, it appears that acetone condenses with benzaldehyde or with vanillin in the presence of hydrochloric acid, to form a bimolecular compound, arising from the condensation of two molecules of aldehyde and one of acetone, whilst, in the presence of hydrochloric acid, methyl ethyl ketone gives different condensation products, according as benzaldehyde or vanillin is condensed with it. Therefore, it seemed interesting to study the condensation of various phenolic aldehydes and their ethers with methyl ethyl ketone—alkali, concentrated hydrochloric acid, or dry gaseous hydrogen chloride being used as the condensing agents.

The author condensed methyl ethyl ketone with protocatechualdehyde, veratraldehyde, piperonal, p-hydroxybenzaldehyde, anisaldehyde, m-hydroxybenzaldehyde, or with m-methoxybenzaldehyde under various conditions. The condensation may be represented by one of the following three cases :—

$$RCHO + CH_3COC_2H_5 \rightarrow RCH :CHCOC_2H_5 \quad (A)$$
$$RCHO + CH_3COC_2H_5 \rightarrow RCH :C(CH_3)COCH_3 \quad (B)$$
$$2RCHO + CH_3COC_2H_5 \rightarrow RCH :CHCOC(CH_3) :CHR \quad (C)$$

The constitution of the products (A) and (B) was determined by analysis, and by the formation of oxime and dibromide, and they were differentiated from each other by using sodium hypochlorite, when substance (B) yielded chloroform and an acid with one fewer carbon atom than the original ketone, as shown in the following scheme :—

$$RCH :C(CH_3)COCH_3 + 3NaClO = RCH :C(CH_3)COONa + CHCl_3 + 2NaOH.$$

The compounds which were expected to be, on analysis, of the type (C) had no definite melting point and it was difficult to convert them into crystalline derivatives.

When protocatechualdehyde or veratraldehyde was condensed with methyl ethyl ketone in equi-molecular quantity in the presence of hydrochloric acid, a bimolecular compound of type (C) was obtained. In the case of p-hydroxybenzaldehyde or anisaldehyde, the condensation product, in the presence of hydrochloric acid, was a unimolecular compound when each molecule of aldehyde and ketone was used, and this was the case even when half the quantity of the latter was used, *i.e.*, a condition which is in favour of bimolecular formation of the compound. It thus follows that the formation

of a bimolecular compound is not the effect of the hydroxyl or methoxyl group in para-position to the aldehyde group. On the contrary, it is the effect of the hydroxyl or methoxyl group in meta-position to the aldehyde group. In the support of this view, the substance of type (C) was the sole product of the condensation of methyl ethyl ketone with m-hydroxybenzaldehyde and its ether, in the presence of hydrochloric acid, even when each molecule of aldehyde and ketone, favourable to the formation of a unimolecular compound, was used.

In the presence of dilute alkali, the condensation products of methyl ethyl ketone with various aldehydes were found to be unimolecular compounds.

CHEMISTRY AND THE SUPPLY OF DRUGS.

By Norman Evers, B.Sc., F.I.C.

(*Before the Royal Society of Arts, February* 2, 1927.)

The application of chemistry to the supply of drugs may be said to date back to the beginning of chemistry itself. Chemistry in fact in its earlier stages was evolved largely in attempts to prepare new drugs. The earlier chemistry, however, was chiefly concerned with inorganic compounds. Before the beginning of the nineteenth century natural drugs were used in the crude state or as various preparations such as tinctures, extracts ,etc. Towards the 16th century, the failure of the alchemists to achieve their purpose and the general increase of medical knowledge resulted in attention being directed to the possibility of the use of chemical preparations as medicines. Paracelsus was the pioneer in this direction, and a famous dictum of his was that "The true use of chemistry is not to make gold but to prepare medicines." Paracelsus introduced the use of antimony compounds, which had so long a popularity in the treatment of disease. The work of van Helmont and the rise of the iatro-chemical school at the beginning of the 17th century firmly established the use of chemical medicines.

Early in the nineteenth century, however, definite organic compounds extracted from the natural drugs began to be used. Camphor was first used in this country about 1800. In 1804 the first alkaloid, morphine, was isolated from opium, followed in 1809 by the equally important discovery of quinine in cinchona bark.

The following table is interesting as showing the dates when the most important alkaloids were first isolated.

Dates of Isolation of the More Important Alkaloids.

1804	Morphine.
1809	Quinine.
1811	Emetine.
1817	Strychnine, Narcotine.
1819	Brucine.
1820	Cinchonine, Colchicine.
1821	Caffeine.
1826	Berberine.
1827	Coniine.
1832	Codeine.
1833	Atropine, Hyoscyamine.
1835	Thebaine.
1848	Papaverine.
1855	Veratrine.
1860	Aconitine, Cocaine.
1862	Hydrastine.
1864	Physostigmine.
1868	Quinidine.
1875	Pilocarpine.
1877	Lobeline.
1889	Hyoscine.
1883	Gelsemine.
1896	Yohimbine.
1906	Ergotoxine.
1920	Ergotamine.

As will be seen from this table, practically all the important alkaloids were discovered before 1884, and the alkaloids had been gradually coming into use in place of the crude drugs from which they were derived, with the advantage of more accurate dosage and more certain therapeutic effect. Morphine and quinine sulphate were first made in England on a commercial scale in 1821, and the salts of other alkaloids quickly came into use in medicine within a few years of their discovery. It was at first thought that the alkaloids could and would replace completely the natural drugs, but it was later found that the action was not always by any means the same; for example, the action of porphine was found to be different in certain respects to that of opium, with the result that to-day not only are many preparations of crude opium stil lin use, but we have preparations consisting of mixtures of all the alkaloids of opium as they exist in the drug. There are indeed a few alkaloids, notably cocaine, physostigmine, and pilocarpine, which may be said to have practically replaced the natural drugs, but nearly all the other alkaloidal drugs are still used in the crude form.

The earliest attempts to modify the structure of natural products so as to produce a modified therapeutic effect were made on the alkaloids. Cotarnine was first made in 1844, though it was some years before it was used in medicine. Apomorphine was made in 1869, and is probably the first instance in which an organic compound the structure of which had been modified by chemical methods was used in medicine. Homatropine was discovered in 1880 and is a parallel example.

The year 1884, in fact, may be regarded as a turning-point in the history of drugs. Before that date there were, as has been said, numerous natural alkaloids in use and derivatives of these had been prepared, but the synthetic drugs were practically unknown. Phenol, first prepared commercially about 1846, was in common use as an antiseptic. Chloroform had been discovered in 1831 and from the middle of the century had been in use as an anæsthetic. Iodoform had been first prepared in 1868, and was coming into use as an antiseptic. Salicylic acid had been used to some extent since 1875. Chloral had also been in use as a hypnotic. With these exceptions, no synthetic drugs were in use, and the year 1884 marks the beginning of the era of the production of synthetic drugs, which began from that date to pour into this country, chiefly from Germany, in ever-increasing numbers, until the Great War temporarily put a stop to them. It is interesting to note that the production of synthetic drugs had its origin in the search for an antiseptic which would be an improvement on carbolic acid and in particular an antiseptic which could be used internally as well as externally.

The ideal antiseptic has yet to be discovered, but the search for it has led to many interesting and unexpected discoveries.

The following table shows the dates of introduction of the most important synthetic drugs :—

DATES OF INTRO UCTION OF THE MORE IMPORTANT SYNTHETIC DRUGS.

1885	...	Aseptol, β—naphthol.
1885	...	Iodol, Phenazone (Antipyrin) Acetanilide.
1886	...	Salol, Urethane, Hypnone, Thallin.
1887	...	Phenacetin, Amylene Hydrate.
1888	...	Sulphonal, Guaiacol.
1889	...	Exalgin, Chloralamide.
1890	...	Aristol.
1891	...	Phenocoll, Salophen.
1892	...	Guaiacol Carbonate.
1893	...	Formaldehyde.
1894	...	β—eucaine.
1895	...	Lysidine, Lactophenin, Diuretin.
1896	...	Hexamine, Quinosol.
1897	...	Euquinine, Pyramidon, Holocaine.
1898	...	Euphthalmine, Orthoform, Protargol, Thiocol.
1899	...	Aspirin, Diamorphine (Heroin), Acoine, Dionine, New Orthoform, Phenalgin. Xeroform.
1900	...	Chloretone, Cacodylates.
1903	...	Barbitone (Veronal).
1904	...	Stovaine, Trypan Red.
1905	...	Ethocaine (Novocaine).
1906	...	Phenolphthalein, Alypine.
1907	...	Atoxyl.
1908	...	Atophan.
1909	...	Arsenobenzol, Bromural.
1911	...	Adalin.
1912	...	Luminal.
1916	...	Optochin, Chloramines.
1917	...	Acroflavine, Mercurophen.
1918	...	Vuzin.
1919	...	Tryparsamide, Mercurochrome, Bayer 205.
1920	...	Butyn, Stibenyl, Eucuprin.
1922	...	Stovarsol.

A study of the above table shows that the earlier synthetic drugs were the antiseptics, the antipyretics, antipyrin and phenacetin and their allies and the hypnotics of the sulphonal and chloral type. The important group of local anæsthetics followed later, after the introduction of β-eucaine in 1894. The most widely used of the synthetic drugs, acetylsalicylic acid or aspirin, was not introduced until 1899, and the veronal group of hypnotics followed later with the production of veronal in 1903.

During the latter part of the pre-war period new synthetic drugs were appearing in great numbers. The war put a sudden stop to them and created the necessity of manufacturing the few that were really indispensable in this country; incidentally the war taught us how many of them we could do without and numbers of them have never returned to the market. The result of this has been that several of the more important are still made in this country, and as far as quality is concerned, can hold their own, generally speaking, with the products of foreign factories.

Many of these drugs were introduced to the medical profession with little reliable physiological testing. The catalogues of synthetic drug manufacturers of those times indeed remind one of catalogues of roses in

the unstinted praise which is given to the latest productions. The absence of any authority in this country for the testing of such products left the medical profession helpless and confused.

It will be seen from what has already been said that we can sum up the history of chemistry as applied to the supply of drugs by recognising certain more or less well defined periods, namely :—

1.—The period before the nineteenth century when chemistry was occupied in preparing inorganic drugs.

2.—1800 to 1884, the period of alkaloid isolation.

3.—1884 to 1914, the primary synthetic drug period brought to an end by the war.

4.—The post-war period.

Chemistry enters into the supply of drugs in several ways : —

(1) The isolation of the active principles of natural drugs.

(2) The elucidation of the constitution of naturally occurring compounds.

(3) The synthesis of naturally occurring compounds.

(4) The preparation of drugs by the modification of the structure of naturally occurring compounds with change in physiological action.

(5) The preparation of synthetic drugs.

(6) The preparation of inorganic drugs and chemicals in a state of purity.

(7) The analytical control of the supply of drugs.

(8) The preparation of drugs in suitable forms for administration.

The isolation of active principles includes compounds of widely-varying chemical character, such as alkaloids, glucosides and hormones. Generally speaking, the preparation of alkaloids from plant material is a simple matter, and, in fact, as has already been mentioned, most of the important ones were prepared many years ago. The determination of their constitution, however, is a much more difficult problem, and even to-day the structure of some of the best known, such as morphine, strychnine and emetine is still undecided. Many alkaloids have been synthesised; the most recent triumph in this direction having been the synthesis of cocaine by Willstätter. No alkaloid, however, has yet been prepared synthetically on a commercial scale at a price at which it can compete with the natural product. When we come to deal with glucosides we are faced with a much more difficult problem. Instead of dealing with readily crystallisable compounds which form numerous crystalline salts and compounds, as the alkaloids are, we are handling compounds which are not easily crystallised, which form few derivatives. They are usually present in very small proportion in plants. It often happens, too, that several glucosides of similar properties occur in the same plant. Their separation and the determination of their composition is, therefore, a matter of great difficulty. Some progress has, however, been made recently in this direction and has disclosed the important fact that there probably exists a close relationship between the members of the group of glucosides known as the heart poisons. When the sugar group is removed by hydrolysis the sugar-free products are hydroxylactones and probably have a similar carbon skeleton. Compare, for instance the following formulæ of the hydrolytic products of some heart poisons.

Antiarin	Antiarigenin	$C_{21}H_{28}O_5$
Digitoxin	Digitoxigenin	$C_{22}H_{32}O_4$
Digitalin	Digitaligenin	$C_{24}H_{32}O_3$
Strophanthin	Strophanthidin	$C_{23}H_{32}O_6$
Cymarin	Cymarigenin	
Bufotoxin	Bufotalein	$C_{24}H_{30}O_3$

Bufotoxin is not a plant product at all, but the poisonous principle of toad venom, an interesting if not unique example of two chemically related bodies of similar pharmacological action occurring in the animal and vegetable kingdoms.

When we come to the isolation of the hormones we are confronted with an even more difficult problem than that of the glucosides. The active principles are often present in extremely minute amounts, they are unstable and easily decomposed by heat or chemical action.

General Notes.

LATIN AMERICA IN 1927.

In view of the fact that the loans and securities floated in the United States in 1926 by the countries, states, cities and companies of Latin America totalled $400,000,000, it would seem that the recent annual reviews of world business conditions have given too little attention to the immediate expansion which is likely to come in that part of the world. During 1926, for instance, the loans to the government, provinces and cities of Argentina amounted to $110,293,000; to Brazil, $71,500,000; to Chile, $53,500,000 and to Uruguay, $35,000,000; while the names of most of

the other countries of South and Central America appear on the list of those who floated issues in New York.

In addition to these loans, there have been a substantial number of corporate issues placed in the NewYork market by companies operating in this territory. Sixty-five million dollars' worth of such securities was placed by companies operating in Chile, $9,000,000 by companies in Colombia, $3,780,000 by companies in Venezuela, $8,000,000 by companies operating in more than one South American country, $3,500,000 by companies operating in Central America, and $46,000,000 by companies operating in Cuba and the Dominican Republic. As these companies have interests in sugar, oil, copper, agriculture and other important industries in Latin America, this $130,000,000 of corporate financing should have a decided influence upon the industrial activity of the countries concerned.

USES OF ASBESTOS.

Asbestos is textile, incombustible and a good insulator of both heat and electricity. These qualities are not found combined in any other mineral substance. It can stand temperatures up to 800° or 1000° F., without bad effects. It is used for making incombustible theatre curtains; protective gloves, leggings and aprons for metallurgical works, fireman's garments, for steam packing, packing sheets, gaskets and washers, ropes and yarns, heat insulating coverings and jackets for steam boilers and steam pipes, fire proof felts and papers, fireproof building materials, asbestos shingles, and boards, lagging for railway locomotive boilers, and marine engines, insulating covering for electric wires, brake-band lining for automobiles, etc.

DEVELOP NATURAL SALT CAKE DEPOSIT.

A deposit of sodium sulphate near Palo on the Canadian National Railways transcontinental line west of Biggar, Sask, is being developed by the White Shore Chemical Company of North Battleford, Saskatchewan, and a force of men is now engaged in cutting the salt Two thousand tons were to be taken out this winter and when a market has been established a modern plant will be installled. The Company has 1,500 acres under lease and hopes to increase this considerably.

The Dominion Department of Mines has frequently called attention to the large deposits of natural Glauber's salt (sodium sulphate) occurring in the alkaline lakes of Western Canada, particularly in Saskatchewan. From a survey of the lakes which contain beds of this material, it has been estimated that there is a reserve in excess or one hundred million tons in Western Canada, available for development. Sodium sulphate is used by textile dryers and in kraft paper mills and for these purposes methods have been devised for dehydrating the natural material so as to ship it in concentrated form. The product is commonly called salt cake.

CANADIAN BIRDS.

For the delegates to the Empire Mining and Metallurgical Congress who have made ornithology a hobby it may be of interest to know that two highly commended and well illustrated publications on birds have been published by the National Museum of Canada, Ottawa. These are " Birds of Eastern Canada," and " Birds of Western Canada." " Birds of Eastern Canada " consists of 234 pages with numerous text figures and 50 coloured plates and sells in heavy paper covers at 50 cents, or cloth bound at $1.00. "Birds of Western Canada" consists of 380 pages with numerous text figures and 84 coloured plates and is sold in heavy paper covers at 7 5cents, or cloth bound at $1.25. Application should be made to the Director, National Museum of Canada, Ottawa, Canada.

FLAMES IN GASEOUS MIXTURE.

There are a number of methods employed scientifically for the study of the movement of flames in gaseous mixtures. In a paper by O. C. de C. Ellis entitled " The Study of Flame Movement " (Safety in Mines Research Board, Paper No. 32, H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2., price 1s. net), the principal methods are outlined. Some of the earliest enabled the speed of the flame to be measured under different conditions of the gaseous mixture, but did not permit a close determination of its mode of movement.

This obstacle has been largely overcome by a new method of " snapshot " photography described in the paper, by means of which the spreading of the flame in a totally or partially closed vessel can be studied.

AVERAGE VALUES OF CANADIAN LIVESTOCK, 1926.

The Dominion Bureau of Statistics at Ottawa show reports that the average values of farm livestock by ages in 1926 show for Canada a further increase for all descriptions, excepting for sheep, the average value of which remains at$10 as in 1925. For Canada, the average value for horses under one year old was $30, as compared with $29 in 1925 and $27 in 1924; horses one year to under three years were $61, as against $59 and $54, and horses three years old and over were $95 ,as against $93 and $90. Cattle under one year averaged $14, as against $12 in 1925, and $10 in 1924; cattle one year to under three years $30, as against $28 and $24; and cattle three years and over $43 ,as against $41 and $36.

The total value of farm livestock in Canada for the year 1926 aie given as follows, with the comparative figures for 1925 placed within brackets : Horses—No. 3,558,849; value $254,675,000 (3,554,041; $245,760,000); milch cows—No. 3,951,335; $205,816,000 (3,830,175; $193,980,000); other cattle—No. 5,208,815; $161,920,000 (5,477,123; $168,037,000); all cattle—No. 9,160,150; $367,736,000 (9,307,298; $362,026,000); sheep — No. 3,035,507; $30,273,000 (2,755,558; $26,725,000); swine — No. 4,470,771; $71,971,000 (4,426,148; $69,702,000).

The estimated total value of these descriptions of farm livestock amounts for 1926 to $724,655,000, as compared with $704,287,000 in 1925.

By provinces the total values are as follows : Prince Edward Island, $8,877,000; Nova Scotia $19,355,000; New Brunswick $16,845,000; Quebec $131,818,000; Ontario $236,061,000; Manitoba $57,799,000 Saskatchewan $135,622,000; Alberta $98,021,000; British Columbia $20,047,000.

FRENCH REGULATIONS RELATIVE TO TRANSACTIONS IN CEREALS.

The British Commercial Counsellor at Paris has forwarded an extract from the *Journal Officiel* of March 29, giving the text of a Ministerial Order which lays down conditions for the control of transactions in cereals at the Paris Produce Exchange. The Order, which relates to transactions in wheat, wheaten flour, rye and oats, provides that all quotations shall represent net cash prices per metric quintal, goods being taken at recognised warehouses in Paris or the provinces, and indicates the method to be applied in arriving at a parity between Paris and procincial prices. Provision is also made for setting up a committee of four members to determine, at the end of each day's trading, a representative quotation for the day which shall serve as basis for the monthly fixing of a price which must not be exceeded during the subsequent month by more than a specified margin.

BRITISH COAL OUTPUT.

For the week ending April 9, 1,028,300 miners were employed (the highest number since the general strike), while the coal mined amounted to 5,294,400 tons, also the largest quantity since the strike.

LARGEST PRODUCERS OF WOOD PULP.

Sweden produces more chemical and mechanical wood pulp than any other country, the amount for 1926 totalling 3,015,142,400 lbs.; Canada comes second with 1,992,734,600 lbs. Norway is almost equal to Canada with 1,839,784,000 lbs.; Poland comes fourth with 909,636,100 lbs.; Germany has less than half of Poland's output; while Czecho-Slovakia has only 627,702,800 lbs.; and the U.S.A. less than half the last figure; and Newfoundland, 28,472,000 lbs.

CANADA FIRST FOR NEWSPRINT.

The total quantity of newsprint paper exported by the twelve principal exporting countries in 1925 was 5,045,661,500 lbs., of which amount Canada contributed 2,803,309,100 lbs., or 55.5 per cent., and the other eleven countries combined, 2,242,352,400 lbs., or 44.5 per cent. Canada's exports, therefore, exceeded those of the other eleven countries combined by 560,956,700 lbs. To-day Canada's exports of paper exceed those of any other country in the world, and in the matter of newsprint paper her exports are probably greater than those of the rest of the world combined.

SYNTHETIC THYROXIN.

It is significant that the two awards made at the annual general meeting of the Chemical Society on March 24, should have been to workers on the constitution of natural products of therapeutic interest. Prof. R. Robinson's work on alkaloids earned for him the Longstaff Medal, whilst the Harrison award went to C. R. Harington for brilliant and rapidly executed research on the active principle of the thyroid gland.

Kendall, working in the United States, had expressed the view that thyroxin contained the 4 : 5 : 6 tri-iodo 2 : 4 : 5 : 6 tetrahydro-indol nucleus and gave an empirical formula $C_{11}H_{10}O_3NI_3$. Harington, believing the properties of thyroxin were more satisfactorily accounted for by ascribing to it a different structure, synthesised 3′ : 4′ : 5′ tri-iodo phenylpyrrolidine carboxylic acid, with the disappointing result that the product had not the physiological properties of thyroxin. By attacking the natural substance intself he managed to obtain a 0.12 per cent. yield from the thyroid, many times greater than Kendall had obtained, and found that the empirical formula was $C_{15}H_{11}O_4NI_4$. The percentage composition of this substance is not very different from that proper to Kendall's formula which was based on rather slender evidence. That a study of the constitution of the substance which he found to be an iodine derivative of the parahydroxyphenyl-ether of tyrosine.

The Lancet.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting on Thursday, March 31, 1927 :—

Alloys of Iron and Manganese of Low Carbon Content. By Sir Robert Hadfield, F.R.S.

The paper gives the results of the examination of a series of Iron-Manganese alloys low in carbon, prepared by the author. The range of alloys covers 0.06 per cent. to 38.90 per cent. Manganese, also one additional alloy containing 83.50 per cent. Manganese. The tests comprise tensile, shock, Brinell, and bending tests on the forged material in three separate physical conditions, (*a*) as forged, (*b*) slow-annealing at 860° to 890° C., (c) water-quenched from 1,000° C. Also measurements of specific magnetism in these conditions, and after long heat treatment at 500° C. ,such as renders Manganese-Steel magnetic.

The electrical resistance of the alloys was determined, and the resistance to corrosion at certain percentages under atmospheric exposure, tap-water, and in sea-water was ascertained, these tests being carried out on the materials in their water-quenched condition. Further, the microstructures of representative alloys were examined in the conditions of both forged and water-quenched.

From 4.00 to 10.00 per cent. Manganese, the alloys have a comparatively high Brinell hardness, in the region of 400, and are brittle; from 15.00 to 39.00 per cent. Manganese characteristics are observed similar to those of Manganese-Steel ,though only to a limited extent—that is, a comparatively low Brinell hardness, in the neighbourhood of 200, with considerable tenacity and ductility and fair capacity for work-hardening. The alloy containing 83.50 per cent. Manganese is hard, brittle and unforgeable.

Magnetic determinations show that with 16.00 per cent. or more of Manganese the alloys are non-magnetic, whereas in the presence of 1 per cent. of Carbon not more than about 7 per cent. Manganese is required, to take away or suppress the magnetic qualities of the iron. The electrical resistance, while increasing with Manganese percentage up to 87.2 microhms per cubic centimetre for the 38.90 per cent. alloy, does so in a fairly continuous manner and without any changes of a critical character such as those observed for the specific magetism. In their corrodibility the alloys show under some conditions a somewhat improved resistance as compared with ordinary steel, but not such as to make them of any practical value in this connection. In their microstructure the alloys with increasing Manganese percentage pass at 4 per cent. from a pearlitic structure to a martensitic, which at about 16 per cent., that is, the point where almost completely non-magnetic qualities appear, changes into the austenitic type.

The Thermal and Electrical Conductivity of a Single Crystal of Aluminium. By E. Griffiths, F.R.S.

A method is described for the determination of the thermal conductivity which does not necessitate any machining of the crystal.

Tests were made at various temperatures, the value of the thermal conductivity at 100° C. being 0.55 C.G.S. units.

The specific electrical resistivity is 2.89 $\times$ 10^{-6} ohms per cm. cube at 18° C.

The Transverse Magneto-Resistance Effect in Single Crystals of Iron. By W. L. Webster. Communicated by Sir Ernest Rutherford, P.R.S.

The experiments described deal with the change of resistance of single crystals of

iron produced by a transverse magnetic field. Measurements were made with the current along a (100), (110) or (111) crystal axis, and with the field in a series of positions in the plane normal to these directions.

The results indicate that the phenomenon is of a double nature. There is in all cases a gradual decrease in resistance approximately proportional to the field, and probably due to the action of the field on the conducting electrons. Superimposed on this effect, there is a sudden change in resistance between 5,000 gauss and 12,000 gauss, whose sign depends on the direction of the current and whose magnitude depends on the direction of the field. This second effect is probably caused by the change of orientation of the atoms accompanying magnetisation.

The Initial Stages of Gaseous Explosions. Part III. The Behaviour of an Equimolecular Methane-Oxygen Mixture When Fired With Sparks of Varying Intensities. By W. A. Bone, F.R.S., R. P. Fraser and F. Witt.

The paper embodies the results of photographic studies upon the initial phases of the explosion of an equimolecular methane-oxygen mixture when ignited by sparks of varying intensities passed between electrodes fixed half-way along a horizontal glass tube (35 to 50 cms. long by 2 to 2.5 cms. diameter) both ends of which were *closed* in one series of experiments but *open* in another. A few supplementary experiments were also made under other spark-igniting conditions.

The new evidence, which mainly lies in the photographs themselves, shows (*a*) the occurrence, under ordinary sparking conditions, of what seems to be a definite " indication period " as a preliminary to the actual combustion, (*b*) initial propagation through the medium of a " ghost-like flame " condition involving only a very partial combination of the gases, and (*c*) the main combustion, following later as the result of the superposing of a compression wave, or the like, upon a system which during the phase (*b*) has already become highly sensitive to chemical changes.

The Expansion of Charcoal on Sorption of Carbon Dioxide. By F. T. Meehan. Communicated by Sir William Hardy, F.R.S.

It is shown that wood charcoal expands when it sorbs carbon dioxide. The process is reversible. The relations between expansion, pressure and temperature are found to be similar to those connecting quantity of gas sorbed with pressure and temperature. Thus, at constant temperature, the expansion is related logarithmically to the gas pressure; at constant pressure, the expansion is inversely proportional to the temperature. The same relations hold above and below the critical temperature of carbon dioxide. As the expansion is uniform in the three original grain directions, it appears that carbonisation destroys the structure of wood, leaving an isotropic product.

The Equation of State of a Gaseous Mixture. By J. E. Lennard-Jones and W. R. Cook. Communicated by R. H. Fowler, F.R.S.

A theoretical formula is given for the equation of state of a gaseous mixture and from it is deduced a generalisation of Dalton's partial pressure law. It is shown that the second virial coefficient of a binary mixture is a quadratic function of the relative concentrations—a law which satisfactorily accounts for some recent experimental results. A method of determining the forces between the unlike molecules of a mixture is deduced.

THE SPECTRUM OF THE AURORA AND THE CONSTITUTION OF THE UPPER ATMOSPHERE.

By J. C. M'Lennan, LL.D., D.Sc., F.R.S., M.R.I., Professor of Physics and Director of the Physical Laboratory, University of Toronto.

Read before the Royal Institution of Great Britain on Friday, June 11, 1926, Sir Robert Robertson, K.B.E., M.A., F.R.S., Honorary Secretary and Vice-President, in the chair.

A study of the spectrum of the aurora has a direct bearing on the problem of the consittution and state of the upper atmosphere.

Our present knowledge of the upper atmosphere, apart from that gained by mountain climbing and by aeroplane ascents, or by the use of small free sounding balloons carrying automatically recording meteorographs, has been obtained hitherto chiefly from deductions made from observations on the flight and luminosity of meteors, from investigations on the abnormal audibility of sound waves generated by powerful explosions, and from investigations on the propagation and reflection of wireless ether

waves. In addition, direct evidence of the presence of certain constituents in the upper atmosphere, such as ozone, water and carbon dioxide, for example ,has been obtained from a study of the absorption spectrum of the sun's radiation.

1. *The Stratosphere.*—Aeronauts have flown as high as 13 km., *i.e.*, approximately eight miles, or two and a half miles higher than the top of Mount Everest, and free sounding balloons carrying automatic instruments have reached heights a little beyond 25 km. Through these agencies we have learned that the temperature, as well as the pressure of the atmosphere, steadily decreases with elevation until a height of approximately 10 km. is reached. At this height a region is encountered known as the stratosphere, where the temperature is stationary at approximately 220° Abs., or 53° C. below zero. As to the height of the upper boundary of this stratosphere, no information has yet been furnished by the records obtained with sounding balloons.

In the case of a sounding balloon recently released at Oxford, a height of 20.1 km. was attained before bursting took place, and the recording meteorograph, that was fortunately recovered, showed that the stratosphere was reached at 9.9 km. with a temperature of 231° Abs. Above this point not more than 2° change occurred at any point up to the maximum height of the balloon's flight.

2. *Lindemann and Dobson's Theory.*—From evidence provided by many observations on the flight and luminosity of meteors, Lindemann and Dobson have been led to conclude that the stratosphere does not extend beyond 55 km., or 60 km., and that at this height there is a rapid rise in the temperature of the atmosphere to approximately 300° Abs. The region in which the higher temperature is supposed to be maintained is the one in which the meteors are luminous, and since luminosity generally begins with meteors at a height of 150 km., this elevation is considered to represent approximately the upper boundary of this region of higher temperature.

3. *Audibility of Explosions.*—Evidence in support of the existence of this region of higher temperature in the upper atmosphere has recently been brought forward by F. J. W. Whipple in dealing with the abnormal audibility of explosions. In such a region the velocity of sound would be high, and Whipple has pointed out that this would account for the recurving of sound rays at great heights. This in turn enables one to offer an explanation of why explosions are often audible at some distance from the seat of the explosion while they are inaudible at intervening points. Such an explanation of the abnormal audibility of explosions demands, however, according to Whipple, that the transition from the stratosphere should take place at a height of approximately 30 km., and that in the superincumbent atmosphere a temperature even higher than 300° Abs. should exist.

4. *Propagation of Wireless Ether Waves.*—From experiments on the transmission of wireless ether waves it is now conceded that anomalies observed in the propagation of such waves can be explained by assuming the existence in the upper atmosphere of the so-called Kennelly-Heaviside conducting layer. The thickness of this layer of ionised gas has not as yet been determined, but it is believed to extend down to 40 or 50 km. from the ground by day, and to a height of about 90 km. by night, the rise in the under surface being due to the progressive recombination of ions at the lower levels after sunset. Assuming the conductivity of the layer to be due to the presence of electrons and positive molecular ions, Professor Chapman has shown that the electron density in the conducting layer at about 90 km. is at least 100,000 per c.c. at night. In this connection Professor Chapman has also pointed out that an ionisation of this amount is ample to provide for the diurnal variations that occur in the earth's magnetic field without assuming an excessive thickness for the Kennelly-Heaviside layer.

5. *Ozone in the Upper Atmosphere.* While the ionisation of the upper atmosphere by day might be attributed to the direct action of the ultra-violet light in the solar radiation, its persistence at night rather points to the formation by the sun's rays of some substance that gradually breaks up or dissociates into ions. The existence of such a delayed dissociation would account for the persistence of the ionised layer during the night, and for the rise observed in the height of its lower boundary on the approach of darkness. The evidence points to ozone as the substance able to fulfil these conditions. From the experiments of Fabry and Buisson, as well as from those of Harrison and Dobson, on the absorption of solar radiation, it is known that ozone exists in the upper atmosphere to such an extent that it is equivalent to a layer 3 mm. in thickness at normal pressure in temperature. It is probable that this ozone is formed out of oxygen by solar

radiation of wave length shorter than λ 2000 A. As ozone is known to absorb selectively radiation of wave length about 9.5 μ, as well as radiations in the visible and in the neighbourhood of λ3000 A, one would expect the region in the upper atmosphere where ozone predominates to be the one characterised by an abnormally high temperature, as well as one possessing high electrical conductivity. The evidence adduced above, it will be seen, seems to point to the approximate identity of the region in the upper atmosphere in which meteors exhibit luminosity with the one that is richest in ozone, and incidentally with the one responsible for the reflection of wireless waves. As 150 km. would seem to be the height of the upper boundary of this region, it follows, if we assume that ozone is present in the atmosphere at this height, that oxygen also must be present. Moreover, on account of its higher density, ozone when found must gradually sink down, and consequently one may reasonably conclude that oxygen exists in the atmosphere at heights very much greater than 150 km.

6. *The Aurora.*—Of all meteorological phenomena auroral displays are considered by many among the most interesting. They occur in both hemispheres, that in the northern being designated as *Aurora Borealis* and that in the south as *Aurora Australis*. The frequency of their occurrence varies with latitude, and is greatest in the two zonal regions that make angles of about 20° with the earth's magnetic axis.

The aurora appears with varying intensities, and in a variety of forms and colours. At times it is seen as a weak diffuse formless luminosity. At other times it appears as luminous draperies, bands or arcs, and then again as luminous beams or rays. These forms are sometimes stationary, and at other times undergo movements more or less rapid. Even pulsating types of luminosity have been observed. The feebly luminous diffuse types of aurora are usually yellowish-green or greenish-white; but, blue, red, violet, and many other colours may occur in the more intense and moving varieties. In the case of curtain or drapery-like forms the upper portion has frequently a greenish colour, while the lower edge is of a deep reddish or pulplish hue.

Since 1907, professor Störmer has devoted much time and effort in Norway at Oslo, Bygdo, Bossekop and other stations towards the determination of the height and position of auroral displays. The method used involved the simultaneous photography of an aurora from two or more stations 4.5 km. to 258 km. apart. With the instruments that he has devised and the technique developed he has found it possible to obtain good photographs with but one second exposure.

From hundreds of photographs taken by Professor Störmer he has calculated the heights of the upper and lower edges of the auroral displays. From these plottings it will be seen that very few displays occur below 80 km., but above this level the number increases rapidly, the most frequent occurrences being those beginning at a height of 106 km. Above 106 km. the number of auroræ fall off rapidly. Some have been observed to extend as high as, or even higher than, 500 km., and the greatest height at which any recorded auroral display has been observed is 750 km. A point of some interest that has emerged from Prof. Störmer's work is that the auroral displays as observed at Oslo extend much higher in the atmosphere than when observed at Bossekop near Finland.

7. *The Auroral Spectrum.*—The earliest observation of the spectrum of the aurora appears to have been made by Angström in 1869. He expressed the opinion that one should expect the spectrum to be the same as that of the electrical discharge in air, but it turned out otherwise, for he found only a " green line " at λ 5567 A, and in addition three very faint lines in the blue region, all of which appeared to be of unknown origin.

Since the time of Angström a number of investigators have studied the auroral spectrum, but with the exception of Gyllenskiold's work in 1886 nothing of an extensive nature appears to have been done until the brilliant series of studies undertaken by Professor Vegard was begun in the winter of 1912-13. In addition a spectral line or band has been observed in the spectrum of the aurora, whose wave length has been variously given by different observers as λ 5269 A, λ 5205 A, λ 5200 A, λ 5233 A, λ 5210 A, λ 5239 A, λ 5207 A, λ 520 B, λ 5228 A, λ 5235 A, λ 5166 A, λ 5230 A.

An examination of the wave lengths given in the table reveals a number of interesting points. In the first place, the list contains no wave lengths that correspond to any radiation emitted by either hydrogen or helium. This would seem to indicate that neither hydrogen nor helium are present in the upper atmosphere to any appreciable extent. Again, the wave lengths λ 4708.7 A, λ 4651.1 A, λ 4728 A, and λ 3914 A are of special interest, for they represent one of

the outstanding features of the auroral spectrum. A photograph by Lord Rayleigh possesses, however, additional and very special interest, for it shows a spectrum of nitrogen contiguous to that of the aurora, both spectra having been taken with the same instrument. In the reproduction of the nitrogen spectrum the bands shown are the well-known negative bands of nitrogen, λ 4708.7 A, λ 4278 A and λ 3914 A. Their identity with the bands of the auroral spectrum is unmistakeable, and it is now universally conceded that these particular bands, which constitute such a prominent feature of the auroral spectrum, clearly establish the presence of nitrogen in the upper atmosphere in the same form and in the same state as we have it at the surface of the earth and in our laboratories.

But the most outstanding feature by far of the auroral spectrum is the radiation of wave length λ 5577 A, that appears in the auroral spectrum as a sharp, strong, narrow, well-defined spectral line.

In some observations made by Professor L. Vegard it was found practicable to photograph the spectrum of the aurora with the light emitted from parts of an auroral display, these parts being at various heights. Photographs so taken showed that the radiation corresponding to the green line, as well as that corresponding to the nitrogen bands mentioned previously, was emitted during a display up to the extreme upper limit of auroral rays, reaching altitudes of several hundred kilometres. Moreover, it appeared from the spectrograms that the intensity of the green line as compared with that of the negative nitrogen bands varied but little over the whole area of the display. If there was any change in the relative intensity at all it was very small, and went in such a direction as to make the negative nitrogen bands relatively stronger with increase in height of the point of origin of the light examined.

8. *Spectrum of the Light of the Night Sky.*—Added interest became attached to this spectral line when it was shown by Dr. W. W. Campbell, Lord Rayleigh, Dr. Slipher, Babcock, and others, that a spectrum could be obtained from the light of the moonless, cloudless night sky whose character and possibly only feature was this puzzling line.

9. *Wave Length of the Auroral Green Line.*—Two years ago Harold D. Babcock made a study of this line in the spectrum of the light of the night sky, with a Fabry-Perot interferometer, on Mount Wilson and at Pasadena. He showed that it could be photographed with but one night's exposure with this instrument almost any night between the third and first quarters of the moon, even when the sky was partly clouded. No prism or other dispersion apparatus was required. The *étalon* was simply mounted in front of a high-speed camera supplied with very rapid green-sensitive plates, and provided with a colour screen when there was much moonlight or diffuse artificial light. Orders of interference amounting to λ 3700, λ 8450, λ15,500, λ 31,000 and λ 85,000 waves were successively used in photographing the interference rings, and from their sharpness it was concluded that the width of the line was not greater than 0.035 A.

The work of Babcock is specially important, for it showed that in seeking for an origin for the auroral green line by laboratory experiments one had to look for a spectral line whose sharpness was of the same order as that of the lines in the spectrum of the iron arc, and whose wave length was known to within one-hundredth of an Angstrom.

An additional point that I should note here in connection with all photographs of the spectrum of the light of the night sky taken hitherto, is that on none of them has there ever appeared any trace of the negative bands of nitrogen λ 4708.7 A, λ 4278 A, 3914 A that are always such a prominent feature of the spectrum of the polar aurora. This would seem to indicate that one must look elsewhere than to nitrogen, at least in its ordinary state, for the origin of the famous green spectral line.

(To be Continued.)

THE PHYSICAL SOCIETY.

Proceedings at the meeting held on Friday, March 25, 1927, at the Imperial College of Science, E. H. Rayner, M.A., D.Sc., in the chair. The following papers were read :—.

Acoustical Experiments with a Mechanical Vibrator. By E. MALLETT, D.Sc., M.I.E.E., A.M.I.C.E.

ABSTRACT.

In this paper some preliminary experiments are described with a mechanical device vibrating a piston at one end of a tube so that a sound wave is emitted at the other. The particle velocities in the sound wave are measured by a Rayleigh disc, and resonance curves are drawn. It is shown how the energy in the sound wave can be

calculated from the results obtained. The experiments are directed towards obtaining a standard source of sound, and the results are encouraging, but a considerable amount of work remains to be done.

DISCUSSION.

Major W. S. Tucker said that the author had described an entirely new sound-producing device of great interest, but he was not convinced as to the purity of the tone obtained. Would the air adjacent to the piston receive the same displacement as the air itself? The resonance curves looked rather blunter than pure sine curves, and he would suggest testing for the presence of harmonics by means of hot-wire microphones suitably tuned.

On the Stationary-Wave Method of Measuring Sound-Absorption at Normal Incidence. By E. T. PARIS, D.Sc., F.Inst.P.

ABSTRACT.

A description is given of apparatus employed for measuring coefficients of sound-absorption by the stationary-wave method. The apparatus differs from that used by earlier workers in the use of (1) a small tuned hot-wire microphone for determining relative pressure-amplitudes in the sound-waves; (2) the employment of a steady velve-driven source of sound with arrangements for maintaining the strength at a constant value; (3) the screening of source and experimental pipe from disturbances due to the movements of the observer. By the employment of a certain procedure the relation between the response of the microphone and the amplitude of the pressure variation in the sound-wave is eliminated. Some examples of the employment of the apparatus for determining the coefficients of absorption at normal incidence of acoustic plasters and hair-felt art given.

FORTHCOMING EVENTS.

UNIVERSITY OF LONDON.

University College, Gower Street, London, W.C.1.

Saturday, April 30, at 7-30 p.m.—Fellows Dinner, Mr. Nathaniel Micklem, K.C., in the chair.

Monday, May 2, at 5 p.m.—First of a course of three public lectures, by Prof. G. Dawes Hicks, (May 2, 9 and 16).

Monday, May 2, at 8-30 p.m.—Centenary Celebrations: Philology at University College. By Prof. R. W. Chambers, Chairman, Prof. Sir Israel Gollancz, F.B.A., (admission by invitation only).

Tuesday, May 3, at 4-30 p.m.—Sensation and Sensory Pathway. First of a course of three public lectures. By Prof. J. S. Stopford, M.B.E., M.D., of the University of Manchester, (May 3, 4, and 5). Lantern illustrations.

Tuesday, May 3, at 5.30 p.m.—First of three public lectures in French (Questions of Historical Methodology and Practice). By Prof. C. V. Langlois, director of The National Archives, Paris. (May 3, and 4.)

INSTITUTION OF ELECTRICAL ENGINEERS.

Thursday, May 5, at 6 p.m.—Annual General Meeting, in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C.2.

WIRELESS SECTION MEETINGS.

Wednesday, May 4, at 6 p.m.—"The Holweck Demountable Type Valve." By C. F. Elwell. "Silica Valves in Wireless Telegraphy." By H. Morris-Airey, C.B.E., M.Sc., G. Shearing, B.Sc., and H. G. Hughes, M.Sc. "Cooled Anode Valves and Lives of Transmitting Valves." By W. J. Picken.

ROYAL SOCIETY OF ARTS.

Monday, May 2, at 8 p.m.—(Cantor Lecture). John W. T. Walsh, M.A., M.Sc., F.Inst.P., A.M.I.E.E., Senior Assistant, National Physical Laboratory, and General Secretary, International Commission on Illumination, "The Measurement of Light." (Lecture II.)

Wednesday, May 4, at 8 p.m.—(Ordinary Meeting.) Professor William E. Dalby, M.A., F.R.S., M. Inst.C.E., Dean of the City and Guilds (Engineering) College, Imperial College of Science and Technology: "English Railways." Brig.-General Sir Brodie H. Henderson, K.C.M.G., C.B., M.Inst.C.E., will preside. (Dr. Mann Lecture, I.)

Friday, May 6, at 4.30 p.m.—(Indian Meeting.) B. C. Allen, C.S.I., formerly Chief Commissioner of Assam: "Assam." Sir Edward A. Gait, K.C.S.I., C.I.E., Member of the Council of India, and chairman of the Indian Section, will preside.

ROYAL INSTITUTION.

Friday, May 6, at 9 p.m.—Major A. Corbett-Smith, R.A., M.A. (Oxon.): "China, and the Real Chinese."

SOCIETY OF PUBLIC ANALYSTS.

Wednesday, May 4, at 8 p.m., at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m.—

"Investigations into the Analytical Chemistry of Tantalum, Niobium and their Mineral Associates—VII. The Precipitation of Tungstic Acid by Tannin. VIII. The Separation of Tungsten from Tantalum and Niobium." By W. R. Schoeller, Ph.D., and C. Jahn.

"The Separation of Vanadium and Tungsten." By S. G. Clarke, B.Sc., A.I.C.

"The Determination of Moisture by the Volatile Solvent Method." By J. M. Jones, and T. McLachlan, A.I.C.

"A Study of Antimony Trichloride as a Possible Quantitative Reagent for Vitamin A." By F. Wokes, B.Sc., F.I.C., and S. G. Willimott, Ph.D., B.Sc., A.I.C.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

9,388.—British Dyestuffs Corporation, Ltd.—Production of anthraquinone intermediates. April 5th.

9,246.—Chemisch-Parmazeutische Akt.-Ges.-Bad Homburg.—Manufacture of quinine solutions. April 4th.

9,421.—Hughes, J.—Carrying out chemical reactions. April 6th.

9,535.—Kirkham & Raymond.—Manufacture of alkaline earth and magnesium salts of eugenol, etc. April 6th.

9,230.—Rheinische Kampfer Ges.—Production of inactive menthol. April 4th.

Specifications Published.

240,840.—Pollack, F.—Process for the treatment of condensation products of carbamide or its derivatives with formaldehyde.

268,420.—Deutsche Gold-Und Silber-Scheideanstalt Vorm Roessler, and Andrich, K.—Process for the production of concentrated solutions of alkali cyanides.

268,426.—Noeggerath, J. E.—High-pressure system for electrolytic production of hydrogen and oxygen.

257,930.—Siemens & Halske Akt.-Ges.—Systems for determining the percentage of carbonic acid by means of its power of absorption for heat rays.

260,568.—Bensa, F. — Manufacture of dimitro products of perylene and its halogen derivatives.

Abstract Published.

266,180.—Calcion hypochlorite.—Urano, S., 3559, Sigamo, Takatacho, and Imai, S., 3012, Kamioku, Okucho, both near Tokio.

Basic calcium hypochlorites, Ca, $(O\ Cl)_2$. $Ca(OH)_2$ and Ca $(O\ Cl)_2$. 2 $Ca(OH)_2$ are made by heating a clear solution of bleaching powder with an addition of slaked lime so as to evaporate it at about 40° C. in a vacuum until the basic hypochlorite separates in crystalline form. The monobasic salt is produced when the evaporation is effected until the solution contains 10 per cent. of available chlorine, and the dibasic salt when the evaporation is effected until the solution contains 6.5 per cent. of available chlorine. The crystals may be dried at 115° C. at ordinary pressure or at 80° C. in a vacuum.

The Latest TRADE MARKS

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FILTRON.

477,926.Chemical substances used for agricultural, horticultural, veterinary, and sanitary purposes.—F. Kendall & Son, Ltd., The Chemical Works, Stratford-on-Avon, Warwickshire. April 13th.

RAYDAS.

477,060.—Chemical substances prepared for use in medicine and pharmacy, but not including bath salts and not including any goods of a like kind to bath salts.—Francis Hammond & Co., Ltd., 76 to 96, Strand, London ,W.C.2. April 13th.

LYPTOSPRAY.

478,115.—All goods in Class 2 which includes chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Lypol, Ltd., 2, College Road, Harrow, Middlesex. April 13th.

CHLOROCAIN.

477,980.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Willows, Francis, Butler and Thompson, Ltd., 89a, Shacklewell Lane, London, E.8. April 13th.

Outlines of an ABBREVIATED NOTATION IN CHEMISTRY

ROBERT SAXON, B.Sc., F.C.S.

(TYPEWRITTEN).

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THE STRUCTURE OF AN ATOM OF NITROGEN. II.

By HAWKSWORTH COLLINS, B.A. (Camb.).

In the *Chemical News*, 1927, CXXXIV., 209, Tables were given, introductory to the present matter, and chiefly concerning the elements which are commonly associated with N in chemical compounds.

The Tables given below are concerned with only one of the seven forms of an atom of nitrogen. The others will be considered in later papers.

Each one of the numbered ninety-six facts (in this paper) together with its corresponding theoretical deduction, contains a distinct discovery, and will take its part in the final elucidation of the structure of nitrogen.

TABLE VII.

THE RELATIVE VOLUME, 3.8, OF NITROGEN.

	Relative Volume.	Theor. S.G.	Obs. S.G.		Corresponds with
(1)	BaN_2O_6 23.98 + 2(3.8) + 6(7.53)	3.39	3.404	Buignet	73, 59
			3.284	Playfair	
(2)	$BaCl_2$ 23.98 + 2(15.085)	3.82	3.82	Schiff	75
(2A)	$BaBr_2$ 23.98 + 2(23.09)	4.22	4.23	Schiff	74
(3)	BaI_2 23.98 + 2(27.75)	4.91	4.917	Filhol	
(4)	$AgNO_3$ 13.29 + 3.8 + 3(7.53)	4.26	4.253 – 4.27	Schroder	76, 58
(5)	AgI 13.29 + 27.75	5.702	5.707	Damour	
(6)	$NaNO_3$ 11.865 + 3.8 + 3(7.53)	2.22	2.22	Karsten	49, 46
(7)	NaCl 11.865 + 15.085	2.17	2.17 20°	Kaye	
(8)	NaBr 11.865 + 23.09	2.95	2.95	Schiff	
(9)	SrN_2O_6 23.98 + 2(3.8) + 6(7.53)	2.76	2.805	Buignet	
			2.704	Playfair	79
(10)	SrO 23.98 + 2.51	3,93	3,93	Karsten	
(11)	PbN_2O_6 19.81 + 2(3.8) + 6(7.53)	4.546	4.58	Filhol	
			4.53	24° Nostrand	81
(12)	$PbCO_3$ 19.81 + 8 + 7.53 + 2(2.51)	6.59	6.60	Smith	
			6.5	John	85
(13)	$CdN_2O_6.3H'_2O.H_2O$ 14.73 £ 2(3.8) + 6(7.53) + 3(14.03) + 18.02	2.45	2.45	14° Laws	43
(14)	$CdCl_2$ 14.73 + 2(15.085)	4.05	4.05	25°/4 Nostrand	
(15)	CdI_2 14.73 + 2(27.75)	5.2	5.54	Kebler	44
			4.576	10° Bodeker	
(16)	KNO_3 22.29 + 3.8 + 3(7.53)	2.075	2.074	15°.5 Holker	16

		Theor.	Obs.		Corresponds with
(17)	KCl 22.29 + 15.085	1.994	1.994	Filhol	
(18)	$CuN_2O_6.6H'_2O$ 7.13 + 2(3.8) + 6(7.53) + 6(14.03)	2.047	2.047	Kahlbaum	
(19)	Cu 7.13	8.836	8.838	Whitney	
(20)	CuS 7.13 + 15.53	4.19	4.16	Nostrand	
(21)	$NiN_2O_6.6H'_2O$ 5.02 + 2(3.8) + 6(7.53) + 6(14.03)	2.05	2.037	22° Laws	
			2.065	14° Laws	
(22)	$NiCl_2$ 5.02 + 2(23.01)	2.55	2.56	Schiff	
(23)	NiP_2 5.02 + 2(10.51)	4.65	4.62	18°/4 Int.	
(24)	NiP_3 5.02 + 3(10.51)	4.16	4.19	18°/4 Int.	
(25)	SrN_2O_6 25.31 + 2(3.8) + 6(7.53)	2.71	2.704	Playfair	
(25A)	$SrN_2O_6.4H'O$ 25.31 + 2(3.8) + 6(7.53) + 4(14.03)	2.116	2.113	Filhol	
(26)	$SrCl_2$ 25.31 + 2(15.085)	2.86	2.80	Karsten	
			2.96	Filhol	
(27)	SrN_2O_6 19.56 + 2(3.8) + 6(7.53)	2.93	2.95	Le Blanc	
(28)	$SrBr_2.6H'_2O$ 19.56 + 2(23.09) + 6(14.03)	2.36	2.36	18° Favre	
(29)	SrI_2 19.56 + 2(27.75)	4.55	4.55	25°/4 Nostrand	
(30)	$AmNO_3$ 0.83 + 4(5.76) + 3.8 + 3(7.53)	1.59	1.58	Hassenfrats	31, 49a
			1.635	Playfair	45
(31)	$AmNO_3.3H_2O$ 0.83 + 4(5.76) + 3.8 + 3(7.53) + 3(18.02)	1.28	1.28	Perkin	45, 30, 49a
(32)	$ZnN_2O_6.6H'_2O$ 9.03 + 2(3.8) + 6(7.53) + 6(14.03)	2.034	2.063	13° Laws	91
(33)	BiZn 21.29 + 9.03	9.04	9.046	Calvert	
(34)	Bi 21.29	9.82	9.82	Roberts	
(35)	NCl_3 3.8 + 3(23.01)	1.655	1.653	Nostrand	
(36)	Aniline $C_6H_5NH_2$ 6(0.71) + 2(15.25) + 3(12.22) + 3.8 + 9.95 + 5.76	1.023	1.025	14° Kopp	v.92, 40, 41
			1.0216	20° Bruhl	42
(37)	m.Cl-aniline 6(0.71) + 3(15.25) + 12.22 + 23.01 + 3.8 + 9.95 + 5.76	1.22	1.243	0° Beilstein *i.e.* 1.227 15°	93
(38)	o-Toluidine $C_6H_4(NH_2)CH_3$ 6(0.71) + 2(15.25 + 12.22) + 3.8 + 9.95 + 5.76 + 16.42 + 12.22	0.997	0.9986	20° Bruhl	see 94
(39)	m.Phenylene diamine $C_6H_4(NH_2)_2$ 6(0.71) + 4(15.25) + 2(3.8) + 4(5.76)	1.126	1.1389	5° Nostrand i.e. 1.128 15°	95
(39A)	Acetoxime $(CH_3)_2$ CNOH 31.67 + 28.64 + 8 + 3.8 + 2.51 + 5.76	0.908	0.8868	75°/4 Nostrand	96

Table VIII.
Heat of Combustion (Gas).

		Theor.	Obs.		Corresponds with
(40)	Aniline $C_6H_5NH_2$ 6(104218) + 2(27100) + 3(27853) + 20500 + 27194 + 26375 =	837136	838470	T	36, 41 see 92

HEAT OF FORMATION (GAS).

(41) Aniline − 6(7800) + 2(7280) + + 3(6527) − 20500 + 7186 + 8005 = −17968 −17450 to −19190 calculated by Thomsen

HEAT OF COMBUSTION OF ORIGINAL ELEMENTS.

(42) Aniline C_6H_7N 6(96418) + 7(34380) + 0 = 819168 36, 40, 42

i.e. (H.F.) 819168 − 837136 = −17986 calculated by H.C. v.41

TABLE IX.
HEAT OF FORMATION (LIQUID FORM).

No.		Theor.	Obs.	Corresponds with
(43)	$Cd.N_2.O_6.3H'_2O.H_2O$ − 25308 −			
	2(20500) + 6(32341) − 3(3205) + 0	= 118123	121160	
(44)	$Cd.I_2$ − 25308 + 2(36226)	= 47144	48830	13
(45)	$N.H_4.N.O_3$ − 20500 + 4(8005) −			, 15
	20500 + 3(32341)	= 88043	88060	
(46)	$Na.N.O_3$ 32747 − 20500 + 3(32341)	= 109270	110700	49a, 30, 31
(47)	$Na.I$ 32747 + 36226	= 68973	69080	49, 6

TABLE X.
HEAT OF FORMATION (AQUEOUS.)

No.		Theor.	Obs.	Corresponds with
(48)	$H.N.O_3$ − 24350 − 23630 +			
	3(32341)	= 49043	49090	
(49)	$Na.N.O_3$ 32747 − 23630 + 3(32341)	= 106140	106000	
(49A)	$N.H_4.N.O_3$ − 23630 + 4(8005) −			6, 46
	23630 + 3(32341)	= 81783	81860	
(50)	$Cu.N_2.O_6$ − 64975 − 2(23630) +		81740	30, 31
	6(32341)	= 81811	82230	
(51)	$Cu.Cl_2$ − 64975 + 2(63870)		81300	
		= 62765	62710	
(52)	$Cu.Br_2$ − 64975 + 2(52930)	= 40885	·40830	
(53)	$Ag.N.O_3$ − 50300 − 23630 +			
	3(32341)	= 23093	23000	
(54)	$Ag.Cl$ − 50300 + 63870	= 13570	13100	76, 4
(55)	$Zn.N_2.O_6$ − 14900 − 2(23630) +			
	6(32341)	= 131886	131700	
(56)	$Zn.Br_2$ − 14900 + 2(52930)	= 90960	90960	
(57)	$Zn.I_2$ − 14900 + 2(37720)	= 60540	60540	
(58)	$Zn.Cl_2$ − 14900 + 2(63870)	= 112840	112840	
(59)	$Ba.N_2.O_6$ 72134 − 2(23630) +			
	6(32341)	= 218920	219000	
(60)	$Ba.Cl_2$ 72134 + 2(63870)	= 199874	199210	1, 73
(61)	$Ba.Br_2$ 72134 + 2(52930)	= 177994	177080	
(62)	$Cd.N_2.O_6$ − 31000 − 2(23630) +			
	+ 6(32341)	= 115786	116120	
(63)	$Cd.O_2.N_2O_4$ − 31000 + 2(32341) +			
	84672	= 118354	118700	
(64)	$Cd.O.N_2O_5$ − 31000 + 32341 +			
	84672	= 86013	86000	
(65)	$Cd.Cl_2$ − 31000 + 2(63870)	= 96740	96400	
(66)	$K.N.O_3$ 37274 − 23630 + 3(32341)	= 110667	110700	
(67)	$K_2.O.N_2O_5$ 2(37274) + 32341 +			
	84672	= 191561	192100	
(68)	$K_2.O_2.N_2O_4$ 2(37274 + 32341) +			
	84672	= 223902	224570	

		Theor.	Obs.	Corresponds with
(69)	$K_2.S.O_4$ 2(37274) + 6217 + 2(32341) + 2(96155)	= 337757	338000	
(70)	$Pb.N_2.O_6$ - 49735 - 2(23630) + 6(32341)	= 97051	97850	
(71)	$Pb..O.N_2O_5$ - 49735 + 32341 + 84672	= 67278	68070	
(72)	$Pb.O_2.N_2O_4$ - 49735 + 2(32341) + 84672	= 99619	100500	
(54A)	$Ag_2.O.N_2O_5$ - 2(50300) + 32341 + 84672	= 16413	16780	
(54B)	$Ag._2O_2.N_2O_4$ - 2(50300) + 2(32341) + 84672	= 48754	49250	

TABLE XI.

HEAT OF FORMATION (SOLID).

		Theor.	Obs.	Corresponds with
(73)	$Ba.N_2.O_6$ 81926 - 2(23630) + 6(32341)	= 228712	228400	4, 59
(74)	$Ba.Br_2$ 81926 + 2(45244)	= 172414	172100	2a
(75)	$Ba.Cl_2$ 81926 + 2(56786)	= 195498	196880	2
(76)	$Ag.N.O_3$ - 45080 - 23630 + 3(32341)	= 28313	28700	4, 53, 77
(77)	$Ag._2O_2.N_2O_4$ - 2(45080) + 2(32341) + 84672	= 59194	60130	4, 76, 53
(78)	$Ag_2.O$ - 2(45080) + 96155	= 5995	5900 7000	5a
(79)	$Sr.N_2.O_6$ 70752 - 2(23630) + 6(32341)	= 217538	219900	9
(80)	$Sr.Cl_2$ 70752 + 2(56786)	= 184324	184500	
(81)	$Pb.N_2.O_6$ - 40607 - 2(23630) + 6(32341)	= 106179	105460	11
(82)	$Pb.O_2.N_2O_4$ - 40607 + 2(32341) + 84672	= 108747	108110	
(84)	$Pb.S.O_4$ - 40607 + 0 + 2(32341) + 2(96155)	= 216385	216210	
(85)	$Pb.C.O_3$ - 40607 - 13855 + 32341 + 2(96155)	= 170189	170000	12
(86)	$K.N.O_3$ 44580 - 23630 + 3(32341)	= 117973	119000	
(87)	$K_2.O_2.N_2O_4$ 2(44580 + 32341) + 84672	= 238514	241610	
(88)	$K.I.$ 44580 + 36226	= 80806	80130	
(89)	$Cd.N_2O_6.H'_2O$ - 31000 - 2(23630) + 6(32341) - 3205	= 112581	113300	
(90)	$Cd.O$ - 31000 + 96155	= 65155	66300 63900	
(91)	$Zn.O_2.N_2O_4.6H'_2O$ 6396 + 2(32341) + 84672 - 6(3205)	= 136520	140820	32

TABLE XII.

MAGNETIC ROTATION.

		Theor.	Obs.	Corresponds with
(92)	Aniline $C_6H_5NH_2$ 3(3.364) + 2(0.235) + 3(0.265) + 3.68 + 0.399 + 0.399	= 15.835	16.076	41, 42 36, 40

(93)	m.Cl-aniline 3(3.364 + 0.235) + 0.265 + 1.645 + 3.68 + 0.165 + 0.399	= 16.951	16.969		37
(94)	o-Toluidine $C_6H_4(CH_3)NH_2$ 3(3.364) + 2(0.235 + 0.265) + (0.459 + 0.165 + 0.399 + 0.265) + 3.68 + 0.399 + 0.399	= 16.858	17.200		v.38
(95)	o-Phenylenediamine $C_6H_4(NH_2)_2$ 2(3.364) + 2.772 + 3(0.235) + 0.265 + 2(3.68) + 2(0.399) + 2(0.399)	= 19,418	19.391		v.38b

TABLE XIII.

OPTICAL REFRACTIVITY.

(96)	Acetoxime $(CH_3)_2$ CNOH 5.5985 + 5.7385 + 3.333 + 3.8 + 1.346 + 0.82	= 20.636	20.47	75°	39a

The above Tables demonstrate that one relative volume of nitrogen *in the solid state* is 3.8 (Nos. 1—39), and that when a substance containing this form of nitrogen is raised to the gaseous state and passed *through the operation of combustion* (No. 40) the N-atom (*i.e.*, gram-atom) absorbs 20500 calories in returning to its original state as an element, so that its H.F. (gas) is - 20500 (No. 41). They also show that the same atom in a liquid form is of the same volume as in the gaseous form (Nos. 43—47) since it has the same heat of formation. Besides this they demonstrate that in aqueous solutions and in solids its H.F. is - 23630 (Nos. 48—91) which by the Law of Heat of Formation requires the original equivalent volume to be 1.677 as in other cases in Table III. ;also that its M.R. is 3.68 and its O.R. 3.8.

There are six other forms of nitrogen re-*meaining to be demonstrated in later* papers.

A molecule of crystallised water is written *H'_2O to distinguish it from liquid* water. The volume of the former at 15° C. *is 14.03, and of the latter,* 18.02.

In No. 38, 16.42 (CH_2) is the sum of 0.71 + 9.95 + 5.76. In No. 39a, 31.67 (CH_3) stands for 16.42 + 15.25; and 28.64 equals 16.42 + 12.22.

In Nos. 92, 94, and 95, the underlined 0.399 has been altered from the normal 0.165 by the magnetic field. There is a general tendency for atoms of H when in combination with N to diminish in volume from 15.25, 12.22, or 9.95 to 5.76, and therefore to alter their M.R. accordingly.

In No. 96,

5.5985 = 2.6685 + 1.125 + 0.82 + 0.985 and

5.7385 = 2.6685 + 1.125 + 0.82 + 1.125

The *facts with regard to benzene-com*pounds can only be adequately expressed by means of diagrams, which however cannot be given owing to the large amount of space they would require.

TURKISH METAL IMPORTS AND EXPORTS.

The British Commercial Secretary at Constantinople has forwarded a translation (in French) of the Turkish Customs Returns for 1924 under Group XXIII. of the Tariff, showing the imports into and exports from Turkey of metals and metal goods by countries of origin and destinations respectively. The Commercial Secretary draws attention to the import figures for tin (Article 479), this being one of the principle commodities in which the United Kingdom appears to be able to compete successfully. The British share of the trade in ingot and bar tin amounted to 277,911 kilogs. out of a total from all countries of 327,797 kilogs. An item of interest on the export side is copper ore, 555,987 kilogs. having been exported from Turkey in 1924, of which 418,958 kilogs were imported by Italy.

The figures contained in the translation referred to are the latest detailed official statistics concerning the metal trades which have been issued, and British firms interested may obtain a copy thereof on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

RECENT ADVANCES IN ELECTROCHEMISTRY.

Increasing Use of Electric Furnaces Calls for Better Refractories Methods for Making Purer Metals Insoluble Anodes and New Methods of Overcoming Corrosion.

By Colin G. Fink, New York, N.Y.

The important developments within the past few years in electrochemistry, in particular in the electric furnace are, in electrometallurgy and in the methods of combatting corrosion are to be the subjects of my discussion.

Many prophesied that the electric furnace was largely a war baby and that the sudden rise in the industry, due to the outbreak of the great war, would be followed by an equally sudden drop after the armistice. However, the curve shows that this prophecy was not correct; the number of furnaces in operation in this country and Canada has continued to increase steadily, so that at the end of 1925 there were over 525 electric steel furnaces in successful operation. What does this mean? It has a big significance, namely, that the entire steel industry has been revolutionised to a certain extent, that we have been able to introduce certain alloys and steel products that we were unable to produce before. On the table is a sample of metallic chromium, analysing more than 98 per cent. chromium, made in the electric furnace. Before the war, the only commercial method of producing chromium was that by the Goldschmidt process. If chromium oxide is mixed with gratulated aluminium, a violent reaction occurs, resulting in the production of metallic chromium. However, the price of chromium so made will always be above that of the raw material, which at the present time is about 27 cents a pound. Furthermore, the chromium metal could only be turned out in small quantities, whereas in the electric furnace, large quantities, ton masses, can be produced to-day. The advent of chromium produced in the electric furnace has brought about an entire new phase in the alloy industry. The fuel-fired furnaces can turn out a low-carbon chromium steel that runs about 3 per cent. chromium, whereas in the electric furnace, 60 per cent. ferro-chromium is daily produced in large masses with almost entire elimination of carbon. It is difficult indeed to turn our ferrochrome very low in carbon. New steels are being produced to-day, for example, the steel with which everyone has become familiar within the last few years, "stainless steel," and which would have been impossible without the low-carbon ferrochrome. The elimination of most of the carbon made it possible to roll the chromium steels into thin sheels and manufacture them into knife blades.

The electric furnace has not only been an important development in the steel industry, but has exerted a great influence in the development of the non-ferrous industry. It is interesting to go through the brass-manufacturing district, through Bridgeport and Waterbury, and note what a remarkable change has taken place in brass-melting during the last four or five years. All of the brass was formerly melted in fuel-fired furnaces by the old crucible method, but the fuel-fired furnace has now been displaced almost entirely by the electric furnace. At first the Baily resistor furnace and the Detroit arc furnaces entered the field. Later on the low-frequency induction-furnace was introduced and is being used to-day to a very large extent. Lately the high-frequency induction-furnace has also entered the field. Practically all brass is made to-day in the electric furnace.

Operating the electric furnace at high temperatures has naturally produced lining difficulties. The best lining material which is universally used is magnesium oxide. The price of the magnesium oxide lining is directly dependent on the percentage of impurity present. A 2 per cent. impurity in the magnesium oxide lowers the selling price very appreciably. But even a lining of the pure oxide can be operated at temperatures of only about 2200° C., so that we are really confronted with a serious situation in not having a refrectory material which will withstand higher operating temperatures. The temperature of the arc in the electric steel furnace is about 4000° C., or about 2000° C. above the temperature that the lining will stand. Water-cooling the lining would be considered poor engineering practice on the basis of academic theory, which would prescribe lagging the furnace, so as to keep all the heat in and thus operate at maximum efficiency. As a matter of fact, however, water-cooling the lining means faster operation, at higher temperatures, and lower overhead charges. The lining difficulty has also promoted greater interest in the induction furnace and, in particular, in the high-frequency furnace. E. F. Northrup, of Philadelphia, has been very active in this field. The high-frequency furnaces that are in operation to-day consist of a water-cooled copper coil through which

the electric current passes. The heat is generated inductively in the centre of the coil. Very high temperatures are attainable in a short time and since the heat is focussed on the metal, the lining difficulties are much less serious than they are in the electric arc furnace.

Along the lines of finding a new refractory that will stand temperatures decidedly above 2500°, I might refer to recent work carried out by the Bureau of Standards, where G. A. Merritt has developed a refractory composed of equi-molecular parts of thoria and zirconia, which has a melting point of 3000° C. However, the price of this refractory is still prohibitive.

In the fused electrolyte field there have likewise been a number of interesting accomplishments. The purest aluminium that has been produced for a good many years is that being produced to-day, containing about 98 to 99 per cent. aluminium. Practically all of the aluminium ware that you are familiar with in your kitchen is made of metal running about 98 per cent. Al. The Aluminium Co., of America, at its New Kensington research laboratory, made an interesting investigation, resulting in final success, some months ago. The proposition put up to the research men was : " Could you not refine aluminium similarly to the method used in the refining of copper and zinc? " The use of aqueous solutions has been found practically impossible for metals of this type, since compounds of aluminium are much more difficult to break up than compounds of copper and lead. It was Hoopes' idea to use a fused-salt refining bath. Unfortunately Hoopes passed away before the problem was completely solved, but Frary and Edwards then continued the research, using a fused fluoride bath; a bath similar to that which Hall had used in the standard aluminium cell. In the Hoopes' cell there is a molten anode, consisting of an alloy of aluminium, copper, silicon, etc., and above this alloy is the fused bath, consisting of aluminium and other fluorides. The scheme is to have the pure aluminium spread out on the upper surface of the fused salt, and in order to do this, it was necessary to increase the specific gravity of the bath so that the pure aluminium rises to the top of the bath and the impure remains at the bottom of the cell. The specific gravity of impure aluminium is a few decimal points higher than that of the pure aluminium, and it was necessary to regulate the density of the bath so as to fit in between. Hoopes added to the bath barium fluoride, which is one of the heaviest fluorides we have. The addition of barium fluoride is made in small quantities until the specific gravity is higher than the anode and lower than the cathode. The refined aluminium thus produced is a product which we have never been familiar before; it is a new aluminium which is almost insoluble in hydrochloric acid. It retains its bright lustre indefinitely, whereas the old aluminium soon turns a dull grey. This has been a big step forward in the aluminium industry. The new aluminium analyses 99.97 per cent. pure, has a tensile strength of 8500 lb. per sq. in., an elongation of 60 per cent. in 2 in., a 95 per cent. reduction in area, and a Brinell hardness of 16, as compared with 13,000,000 lb. per sq. in., 45 per cent. elongation, 80 per cent. reduction in area, and 2 Brinell for ordinary 99.45 per cent. alumium. The pure aluminium will undoubtedly give rise to new aluminium alloys. Those of you who are familiar with metallurgy and the physical properties of alloys will know how these physical properties are greatly affected by mere traces of foreign metals.

Magnesium ribbon imported from Bitterfeld, German, used to disintegrate rapidly. All radio fans are familiar with one use of magnesium in the radio tube. William G. Harvey, of the American Magnesium Corporation, carried out a number of tests in his research laboratory, conceiving the idea that since the fluoride bath has been a big success with the sister metal, aluminium, similar success might me attained in the case of magnesium. Harvey uses a fused electrolyte composed of magnesium fluoride, together with a little calcium fluoride, to which he adds as his regular raw material, magnesium oxide, using magnesium oxide in place of magnesium chloride, as is done at the Bitterfeld works. The magnesium turned out in the Harvey cell and then distilled analyses 99.973 per cent. magnesium. The metal is very stable in the air; it does not tarnish and disintegrate, and the elimination of sodium has resulted in yielding a very pure magnesium from which very fine magnesium wire and very fine magnesium ribbon can be made. I need not remind you of the importance of magnesium in the alloy field for the construction of aeroplanes. A number of magnesium alloys have been produced; for example, so-called Dowmetal, which has sustained a higher fatigue test than cast iron. The magnesium alloy, which contains about 95 per cent. magnesium, and about 2 per cent. copper and a little nickel, broke under 328 impacts as against 22 for cast iron.

(To be Concluded Next Week.)

THE SPECTRUM OF THE AURORA AND THE CONSTITUTION OF THE UPPER ATMOSPHERE.

By J. C. M'Lennan, LL.D., D.Sc., F.R.S., M.R.I., Professor of Physics and Director of the Physical Laboratory, University of Toronto.

Read before the Royal Institution of Great Britain on Friday, June 11, 1926, Sir Robert Robertson, K.B.E., M.A., F.R.S., Honorary Secretary and Vice-President, in the chair.

(*Continued from Last Week.*)

In July, 1923, interest in the auroral spectrum was suddenly stimulated and intensified by a suggestion, put forward by Professor Vegard, that the auroral green line would be found to have its origin in solid nitrogen held in suspension in the upper atmosphere in a fine state of division. This remarkable suggestion was followed early in 1924 by an announcement by Vegard that solid nitrogen when bombarded by swiftly moving electrons became luminescent, and showed a line broad and possibly composite in its spectrum at λ 5577A; also one at λ 5231 A. This result at once appeared to be a remarkably brilliant confirmation of Vegard's bold suggestion. Some time later, however, the present lecturer announced that in collaboration with his associate, Mr. G. M. Shrum, he, too, had been investigating the spectrum of solidified nitrogen rendered luminous by cathode rays, and that instead of a single spectral line at λ 5577 A had found the luminescent spectrum to consist of three broad lines or narrow bands, with the mean wave lengths λ 5556 A, λ 5617 A, and λ 5654 A. It also transpired that the line at λ 5231 A was due to solid nitrogen rendered *phosphorescent* by bombardment with high-speed electrons. The bands λ 5617 A, λ 5654 A, and λ 5556 A, were obtained with the light from solid nitrogen while it was being bombarded by electrons, and the line or narrow band λ 5231 A with the light from solid nitrogen when phosphorescing after the bombardment had ceased. This phosphoresence of nitrogen with its extremely simple spectrum is remarkable in that it appears to be the first instance recorded of phosphorescence being exhibited by an element in a state supposedly very pure.

In the interval that has elapsed since the discovery that solid nitrogen could be rendered luminous and phosphorescent, the subject of the luminescence of solid nitrogen has been very fully investigated by Professor Vegard in Europe, and by myself in association with my colleagues and students in Toronto.

In our later experiments, carried out with the help of my research workers, H. J. C. Ireton and K. Thomson, we have succeeded in intensifying the effect of making use of tubes of a type recently designed by Dr. Coolidge, of Schenectady. These tubes were provided with windows of thin nickel foil through which electrons under a potential of 100,000 volts R.M.S. were projected into the vacuum space of a german-silver thermos flask of special design. The nitrogen was deposited and solidified on the inner wall of the thermos flask within the vacuum space, and the refrogerant used was liquid hydrogen.

The luminescence of the solid nitrogen was observed in our experiments through a fluorite window in the outer wall of the thermos flask, and its spectrum was photographed with glass, quartz, and fluorite spectrographs. All wave lengths measured and given below are in Angstrom units.

Photographs of the spectrum of the light emitted while the solid nitrogen was being bombarded showed :—

(1) A single sharply defined narrow band (N_4) at λ 5945.

(2) Three broad diffuse bands (N_1) shadin each into the other with mean wave lengths of approximately λ 5554, λ 5617, λ 5658

(3) A series of eight clearly defined bands (N_2) with the wave lengths λ 5204.4, λ 5210.4, λ 5214.3, λ 5220.4, λ 5224.4, λ5228.8, λ 5235, λ 5240.

(4) A number of diffuse bands, each shaded off towards the red in the blue and violet spectral region between λ 4500 and λ 2460. Very approximate wave lengths of the heads of these bands were found to be λ 4575, λ 4500, λ 4270, λ 3990, λ 3725, λ 3510, λ 3385, λ 3155, λ 2960, λ 2785 λ 2615, λ 2460. As regards these bands some have been observed by Vegard, and some appear to belong to the well-known second positive band spectrum of nitrogen.

Among a number of interesting results obtained by us, four are worthy of special note :—

(1) We failed to record on our plates, with twenty hours' exposure, any trace of a group of wave lengths designated by Vegard as N_3 that were found by him to include one band at λ 6569, and one with its maximum intensity between λ 6320 and λ 6420. In this connection it might be

stated that our plates were highly sensitive up to λ 7000.

(2) When the tube was in action and the solid nitrogen was strongly luminescent, we always found by visual observation, that when the bombardment was interrupted, the wave lengths of the goup N_1 immediately disappeared from the radiation emitted by the luminous nitrogen, while the red band N_4 and the bands N_2 between λ 5204.4 and λ 5240 persisted some minutes, often very brilliant, but with slowly weakening intensity Vegard has suggested that groups N_2 and N_4 belong to the phosphorescence spectrum of solid nitrogen, and, as will be seen from the results given above, our experiments confirm this view.

(3) As to the group of three bands N_1, we found that they were relatively strong when the solid nitrogen under bombardment had been freshly deposited. But with prolonged bombardments of a given layer of solid nitrogen, the intensity of the group of wave lengths N_1 rapidly weakened, and finally was scarcely sufficient to make the radiation observable. The intensities of the band groups N_2 and N_4, on the other haid, appeared to be unaffected by prolonged bombardment. Since exposures of long duration were required in photographing the complete luminescence spectrum, it was necessary therefore to deposit a fresh layer of solid nitrogen approximately every half-hour.

From these results it is clear that two spectra are obtainable from solid nitrogen, one of which includes the band group N_1 and the other the bands N_2 and N_4. This would go to show that solid nitrogen can exist in two forms, A and B, the one, A, emitting the radiation constituting the band N_1, and the other, B, the radiation constituting the band groups N_2 and N_4. Our experiments support the view that the solid nitrogen is initially deposited in the form A, and that under electronic bombardment, and possibly otherwise, it is soon transmuted into the form B, this form B being the one that exhibite the phenomenon of phosphorescence.

(4) The band group N_2, as originally observed by Vegard and by M'Lennan and Shrum, consisted of a single sharply defined narrow band at approximately λ 5230. This band has been found, however, to be more extensive than was originally supposed, for, as shown above, it is known to consist of at least eight strong and well-defined members.

In a lecture having the character of the present one it is impossible to go into details, and it must suffice to point out that the theory of Vegard, though brilliantly conceived, is not supported by the spectral evidence obtainable from the luminescence of solid nitrogen. It is quite clear that the group of bands we have designated as N_1, with wave lengths λ 5556 A, λ 5617 A, and λ 5654 A, are broad and diffuse, and have none of the characteristics of the wave length λ 5577.35 A of the auroral spectrum. It is impossible to identify any one of these bands or any portion of any one of them with the auroral line. Moreover, if solid nitrogen in a state of fine division were diffused throughout the upper atmosphere it would certainly be rendered phosphorescent, and the auroral spectrum would contain a strong and well-marked composite band at or near λ5230 A having the characteristics of the group of eight bands N_2. Up to the present no band possessing these features has ever appeared in photographs of auroral spectra or in those of spectra of the light from the night sky. We are therefore forced to the conclusion that the auroral green line does not originate in solid nitrogen, and that there is no valid evidence that in the upper atmosphere, in the region in which the auroral light originates, the temperature ever reaches such a low value as that required to solidify nitrogen.

11. *Oxygen and the Auroral Green Line.*—The search for the origin of the auroral green line took on a new aspect a year ago when in collaboration with my assistant, Dr. G. M. Shrum, I was able to show that it was possible to obtain a spectral line from an electric discharge in a mixture of oxygen and one or other of the rare gases helium and neon, with the rare gas in excess, that had all the characteristics of the auroral green lines. It was also obtained by us faintly in pure oxygen at low pressures. Measurements carefully made showed its wave length within the limits of error to be λ 5577.35 A. It can be obtained as a very sharp clearly defined line. Its intensity, depending, as it does, on a number of factors not yet clearly understood, is subject to great fluctuations. During the past few months I have made a careful study of the characteristics of this spectral line, in association with my research workers, Mr. J. H. McLeod and Professor W. C. McQuarrie, and have found that this spectral line λ 5577.35 A can never be observed in the spectrum of any electrical discharge in the absence of oxygen. With pure oxygen we have found its intensity is strongest with the gas at a pressure of 2 mm. of mercury, when the exciting electrical dis-

charge was passed through a tube about 1 m. long and about 3 cm. in diameter.

When currents varying in strength up to 160 milliamperes were used the intensity of the line steadily increased with the exciting current. When an electrical discharge was passed through oxygen mixed with helium, with the former at a pressure of 2 mm. of mercury, the line was obtained with strongest intensity when the partial pressure of the helium was between 15 and 20 mm. of mercury. In a series of carefully executed experiments we found that when the power possessed by the rare gases of enhancing the line relative to an ordinary arc line of oxygen, such as λ 5437 A, assuming this relative intensity in oxygen alone to be 1, was as follows: helium 1.7, neon 4.6, argon 84.2. In some of our experiments we found that when argon in excess was mixed with oxygen the line was obtained with an intensity greater than that of any known line in the spectrum of atomic oxygen having a wave length shorter than λ 6000 A. Viewed under these circumstances with an echelon spectroscope that had a resolving power greater than 200,000, the line still appeared sharp. Moreover, it was single and unaccompanied by any satellites.

12. *Zeeman Effect with λ 6577.35 A.*—Some preliminary experiments were made to obtain the Zeeman resolution of this oxygen line λ 5577.35 A in a magnetic field, and for this purpose the discharge tube was placed along the axis of a coil capable of producing a magnetic field of 3,600 Gauss. When the line was viewed by means of the echelon spectroscope just mentioned, it appeared under longitudinal observation as a beautifully clear doublet. Visual measurements of the separation of this doublet showed it to be equal to that between the outer components of a normal triplet. When the discharge was viewed in a direction perpendicular to the magnetic field the line was too weak for its central component, which doubtless existed, to be seen. This type of magnetic resolution may be taken as evidence that the line λ 5577.35 A is an atomic spectral line, and that it has its origin in an element whose atoms possess levels characterised by odd multiplicity. As a general rule the spectral lines of elements, whose arc spectral terms are of odd multiplicity, break up in a magnetic field into an odd number of components, with one of them in the position of the original line. On the other hand, the lines of elements with arc terms of even multiplicity generally break up into an even number of components, without any component occupying the position of the original line. Up to the present no one has ever in any spectrum observed a line that showed a simple doublet magetic resolution, least of all one with a doublet separation equal to that between the outer components of a normal triplet. As the terms that constitute the basis of the arc spectrum of oxygen are of odd multiplicity, and as it is highly probably from our work on the Zeeman effect that the line λ5577.35 A is resolvable into a normal triplet, we have in the magnetic resolution of the line additional support for our view that the line originates in oxygen.

General Notes.

CHEMICAL INDUSTRIES EXPOSITION.

The shortening of the space of days before the opening of the Eleventh Exposition of Chemical Industries to be held September 26, to October 1, 1927 at the Grand Central Palace, New York City, indicates that a more universal interest will be shown than ever before in the history of the industry.

The management is preparing a Brief on the student's course which will be widely distributed among chemists, colleges, and industries.

The Exposition serves and helps to supply the market for more than forty different industries. It is through such a medium that the various methods, processes, machinery and instruments of precision used in manufacturing and handling chemicals are shown and demonstrated.

Industry's debt to chemical engineers and chemists is increasing at a rapid pace. The modern laboratory of to-day develops astounding facts almost over night saving industry thousands of dollars as well as making the world safer and easier to live in.

His Majesty King George V once said, "Does not experience warn us that the rule of thumb is dead, and the rule of science has taken its place; that to-day we cannot be satisfied with the crude methods which were sufficient for our forefathers, and that those great industries which do not keep abreast of the advance of science must

surely and rapidly decline " The quotation from His Majesty is particularly true, for where would industry be to-day but for science? Unquestionably we as well as industry would still be in the dark ages of the dim past where crude methods and appliances sufficed for our forbears. To-day, however, thanks to science, the Chemical Exposition enables actual comparison and demonstration of the chemist's scientific work and results. The past year of 1926 brought out the following contributions to industry by American Chemists, and their significance is beyond an estimate of value :

It has been shown that silicon can replace tin as a hardening agent for copper and is already in considerable use for this purpose.

A new and rapidly expanding use for chlorine has been developed in the production of ethylene glycol, which may replace glycerine in many applications.

About forty new Azo-colours have been developed in American Research laboratories during the past year and placed on the market by the dyestuff manufacturers.

The examples mentioned are only a few of the outstanding chemical and scientific developments in the field. Chemical research has developed cheap oxygen and the pyroxylin lacquers increase in production following the development of " low viscosity " pyroxylin, a product which may be used in sufficient concentration in a laquer to build up a reasonably thick film with the customary two to four coats thereby making making great inroads on the paint and varnish industry.

At the numerous sections of the Chemical Exposition, many new developments will be exhibited and these in connection with the various papers which will be read, together with the plans being matured for the Students' Course, will cover the chemical and industrial developments as never before.

UNITED STATES PATENTS ACTS : AMENDMENTS.

The Board of Trade have received copies of five Acts amending Sections 476, 482, 4,894, 4,897, 4,900, 4,904, 4,909, 4,910, 4,911, 4,912, 4,913, 4,915, 4,918, and 4,934 of the Revised Statutes of the United States of America and Sections 52 and 129 of the United States Judicial Code, relating to patents.

Special attention may be directed to the amendment of Section 4,934 of the Revised Statutes which prescribes new rates for patent fees, and to the amendment of Section 4,900 of the Revised Statutes which prescribes an alteration in the form of the marking of patented articles as a notice to the public.

Copies of the amending Acts may be consulted in the Public Library of the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C.2.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE FARADAY SOCIETY.

April 23 ,1927.

Note on the Interionic Attraction Theory of Debye and Hückel. By D. L. CHAPMAN.

Attempts have from time to time been made to explain the divergence of the properties of strong electrolytes from the laws which approximately hold in the case of slightly ionised substances. The latest theory is that of Debye and Hückel. The theory is simple and the assumed postulates few in number.

To quote the words of A. A. Noyes who has given an account of the theory : " The fundamental idea underlying the treatment of Debye and Hückel is that owing to the electrical attraction between the positive and negative ions, there on on an average in the neighbourhood of any ion more ions of unlike sign than of like sign ; and that consequently when a solution is diluted, the separation of the ions involves doing internal work against this electrical attraction and a corresponding increase in the energy content of the solution."

I have found a difficulty in understanding that part of the theory which relates to ions of small dimension. To explain this difficulty it will be sufficient only to consider the case of a uni-univalent electrolyte.

Debye and Hückel determine the mean distribution of the ions surrounding a selected ion by the application of the so-called Boltzmann principle and Poisson's equation. If ψ is the mean potential at a point distant, r, from a central ion, then by the Boltzmann principle the number of positive and negative ions respectively present

in an element of volume, dv, at the point will be $ne^{-\frac{\epsilon\psi}{kt}} dv$ and $ne^{\frac{\epsilon\psi}{kt}} dv$, where n is the number of ions in unit volume of the solution, ϵ the magnitude of the charge in electrostatic units of an ion, k Boltzmann's constant, and t the absolute temperature. The density ρ of the charge at the point is obviously $n\epsilon\left(e^{-\frac{\epsilon\psi}{kt}} - e^{\frac{\epsilon\psi}{kt}}\right)$. Substituting this value of ρ in Poisson's equation, we obtain

$$\frac{\delta^2\psi}{dr^2} + \frac{2}{r}\frac{\delta\psi}{\delta r} = \frac{4\pi n\epsilon}{D}\left(e^{\frac{\epsilon\psi}{kt}} - e^{-\frac{\epsilon\psi}{kt}}\right) \quad . . 1$$

where D is the dielectric constant of the solvent.

If we neglect all terms of higher order than the first in the expansion of the exponential terms of the above equation, we obtain

$$\frac{\delta^2\psi}{\delta r^2} + \frac{2}{r}\frac{\delta\psi}{dr} = \frac{8\pi n\epsilon^2\psi}{Dkt} \quad . . . . 2$$

The authors state in a footnote: "We have investigated the influence of the higher terms in the expansion of $e^{\frac{\epsilon\psi}{kt}} - e^{-\frac{\epsilon\psi}{kt}}$ and have thereby been able to show that this influence on the final result is very small. For the sake of brevity these calculations are omitted from this communication."

It is however difficult to see how the approximation can be justified in the case of very small ions.

To (2) there is a simple general solution, namely,

$$\psi = C\frac{e^{-kr}}{r} + C'\frac{e^{kr}}{r} \quad . . . . \quad 3$$

where $\kappa^2 = \frac{8\pi n\epsilon^2}{Dkt}$.

C′ is zero otherwise the potential would be infinity at an infinite distance, and the constant C has the value $\frac{\epsilon}{D}$, because (as the authors state) the potential must reduce to that caused by the central ion when the concentration is infinitesimal and $k = 0$.

Therefore for the particular case under consideration the solution becomes

$$\psi = \frac{\epsilon}{Dr}e^{-kr} \quad . . . . 4$$

From this result the potential due to the atmosphere of ions surrounding the selected ion is found by subtracting from the potential due to the whole system that due to the central ion. We thus obtain

$$\frac{\epsilon}{Dr}(e^{-kr} - 1)$$

which becomes when r is small

$$-\frac{\epsilon k}{D}$$

and this is the potential due to the atmosphere of ions at the point occupied by the central ion. Then from the theory of potential work required to remove all the ions in the solution to infinity is $\frac{1}{2}\Sigma\frac{\epsilon^2 k}{Dr}$. Under the heading "Ionendurchmesser verschwindend" the authors gave the above result as the solution of the problem. Nevertheless if the ions are point charges they cannot (under the joint operation of the Boltzmann principle and of electrostatic forces only) be distributed in the manner portrayed. For consider two ions of opposite sign. The probability that the negative ion will be found at a distance between r and $r + dr$ from the positive ion is $4\pi r^2 C e^{\frac{\epsilon^2}{rDkt}} dr$, and therefore the probability that it will be found in a sphere of radius r having its centre at the positive ion is $4\pi C\int_0^r r^2 e^{\frac{\epsilon^2}{rDkt}} dr.$

The probability that it will be found in the shell of radii r and R is

$$4\pi C\int_r^R r^2 e^{\frac{\epsilon^2}{rDkt}} dr.$$

But

$$\frac{\int_0 r^2 e^{\frac{\epsilon^2}{rDkt}} dr}{\int_r^R r^2 e^{\frac{\epsilon^2}{rDkt}} dr} = \infty \quad . \; . \; . \; 5$$

INSTITUTION OF FUEL TECHNOLOGY.

A joint meeting of the Vice-Presidents and Members of the Councils of the Institution of Fuel Technology and the Institution of Fuel Economy Engineers, was held under the chairmanship of Sir Alfred Mond, at 37, Lowndes Square, S.W.1. at 3 p.m. on Friday, April 29. As President of both Institutions, in November last Sir Alfred Mond, having found a general desire both amongst those most closely associated with the problems of fuel economy and amongst those throughout the country who have a general interest in the question, that the two existing Institutions should be merged into one, suggested terms of fusion.

The following terms of fusion were subsequently accepted by the Councils of both Institutions :—

(1) That the name of the merged Institutions be " The Institute of Fuel."

(2) That the Councils of both Institutions as constituted at present be merged and form the Council of the " Institute of Fuel," and that in the autumn following the inauguration of the Institute of Fuel, a new Council shall be elected by ballot of the members of the Institute.

(3) That the present Honorary Secretaries of each present Institution be joint Honorary Secretaries of " The Institute of Fuel."

At the meeting the final steps for the fusion of the existing Institutions and the inauguration of the " Institute of Fuel " were taken. Sir Alfred Mond expressed his great gratification that the fusion had been successfully accomplished and thanked the Vice-Presidents, Chairman, and Members of the Council of both Institutions for their co-operation in bringing about the present happy result. The essential importance of the problems connected with fuel economy and fuel technology to the future of British industry was becoming increasingly recognised. The Government was vitally interested in the subject and had appointed a National Fuel and Power Committee, of which he had the honour to be Chairman, to investigate and consult upon the various problems in their many aspects. That Committee was progressing satisfactorily with its work and it was of the utmost importance that there should be a unified Institution, important in numbers and personned to investigate, advise and instruct the committee and the community on these highly technical matters. From the readiness to co-operate which had already been shown he felt that the " Institute of Fuel " was being inaugurated under the most favourable auspices. There have been many who had been waiting to join a unified Institute and now doubtless they will all come forward to add strength and numbers to an institution which is to play a great part in the future of British industrial expansion.

Sir Alfred Mond moved the formal Resolutions to give effect to the fusion, which were seconded by Sir Hugo Hirst, who said that on account of the national importance of the subject and of the fact that it was essential there should be one body to deal authoritatively with the problems of fuel technology, he was very glad that the fusion had been affected.

Sir William Larke proposed, and Sir Philip Dawson seconded, the appointments of Mr. H. L. Pirie and Mr. Edgar C. Evans as joint Honorary Secretaries of the Institute of Fuel. This was carried unanimously.

The following were present at the meeting :— Sir Alfred Mond (President), Sir Hugo Hirst, Sir David Milne Milne-Watson, Colonel Sir William Smith, Professor Harold B. Dixon, Professor R .V. Wheeler, Sir William Larke (Chairman, Institution of Fuel Technology), Mr. P. C. Pope (Chairman, Institution of Fuel Economy Engineers), Messrs. G. R. Thursfield, F. A. Freeth, T. Barratt, A. W. A. H. Tomlinson-Lee, John Bruce, J. Gander, T. Trimnell, W. M. Selvey, Edgar C. Evans, S.McEwen, W. A. Woodeson, E. W. L. Nicol, H. L. Pirie, L. C. Harvey, N. W. Travers and T. Hardie.

ROYAL INSTITUTION.

The Annual Meeting of the Members of the Royal Institution was held on Monday afternoon, May 2, Sir Arthur Keith, Treasurer and Vice-President, in the Chair. The Annual Report of the Committee of Visitors for the year 1926, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The Report of the Davy Faraday Research Laboratory Committee was also read. Sixty-four new Members were elected in 1926, and 78 Lectures and 19 Evening Discourses were delivered. The books and pamphlets presented amounted to about 229 volumes, making with the 569 volumes (including periodicals bound) purchased by the Managers, a total of 798 volumes added to the Library in the year. Thanks were voted to the President, Treasurer and Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year. The following gentlemen were unanimously elected as Officers for the ensuing year—

President—The Duke of Northumberland.
Treasurer—Sir Arthur Keith.
Secretary—Sir Robert Robertson.
Managers—Sir John Biles, Sidney G. Brown, Sir James Crichton-Browne, J. Mitchell Bruce, Sir Dugald Clark, W. H. Eccles, Viscount Falmouth, J. S. Highfield, W. E. Lawson Johnston, Sir Henry Lyons, Charles H. Merz, Sir Ernest Moon, The Hon. Sir Charles Parsons, William Stone and Sir Almroth Wright.
Visitors—James H. Batty, F. H. Berryman, W. A. F. Balfour Browne, Alfred Carpmael, H. Vaux Graham, Kenneth R. Hay, Sir Lawrence Jones, William Macnab, C. C. Paterson, R. W. Paul, A. O. Rankine, H. Munro Ross, W. S. Rowntree, Sidney Skinner and F. Coston Taylor.

GEOLOGICAL SOCIETY.

The following paper was read at the meeting held on February 23, 1927 :—

A Critical Revision of the Rugose Corals Described by D. Lonsdale in Murchison's "Silurian System." By William Dickson Lang, M.A., Sc.D., F.G.S., and Stanley Smith, M.A., D.Sc., F.G.S.

The Corals and Polyzoa described and figured by W. Lonsdale in Murchison's "Silurian System" are important, not only for including the genotypes of several genera and the holotypes of a number of species, but also for being some of the earliest-described British Silurian forms. It is clear, then, that a detailed knowledge of both the external characters and the internal structure of Lonsdale's specimens is desirable, especially in view of their misinterpretation by subsequent authors, who have identified some of them with species to which they are not even closely related. Lonsdale, too, has wrongly referred some of his specimens to species already described by former authors. Consequently, the nomenclature of British Silurian Corals is confused; and it is the object of this paper to unravel the tangles so far as the Rugose Corals are concerned, and to put the nomenclature upon a sound footing. Lonsdale's names for these corals are as follows : *Astrea ananas* de Blainville; *Caryophyllia flexuosa* Lamarck; *Acervularia baltica* Schweigger; *Cyathophyllum turbinatum* Goldfuss; *C. angustum* sp. nov.; *C. cæspitosum* Goldfuss; *C. dianthus* Goldfuss; *Cystiphyllum siluriense* Lons.; *C. cylindricum* sp. nov.; *Strombodes plicatum* Ehrenberg; *Turbinolopsis bina* sp. nov.; *T.* sp.; *Cyclolites lenticulata* Lons.; *C. præacuta* Lons.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

Friday, May 13, at 9 p.m.—Sir Humphrey Rolleston, Bart., K.C.B., M.D., LL.D., F.R.C.P., Regius Professor of Physic, University of Cambridge : "Concerning Old Age."

UNIVERSITY OF LONDON.

University College, Gower Street, London.

Tuesday, May 10, at 5.30 p.m.—"National, Regional and Town Development Planning." First of a course of four public Lectures by Mr. W. H. McLean, M.Inst.C.E., M.I.M.E., M.T.P.I. May 10, 17, 24, and 31. (Lantern illustrations.) Chairman at the first Lecture : Dr. Andrew Balfour, C.B., C.M.G., Director of the London School of Hygiene and Tropical Medicine.

Tuesday, May 10, at 7.30 p.m.—Guild of Graduates' Dinner to new Graduates.

Wednesday, May 11, at 3 p.m.—Presentation of Degrees at the Albert Hall.

Wednesday, May 11 ,at 5.30 p.m.—Graduation Service at Westminster Abbey. Preacher : The Right Rev. The Lord Bishop of Chelmsford.

Wednesday, May 11, at 8 p.m.—Graduates' Dinner at the Fishmongers' Hall.

Thursday, May 12, at 5.30 p.m.—" The 'Balance of Power' in History." A public lecture by Professor A. F. Pollard, F.B.A.

Friday, May 13, at 5.30 p.m.—" Platonic Problems." First of a course of three public lectures by Professor John Burnet, M.A., LL.D., F.B.A., of the University of St. Andrews. May 13, 20 and 27. Chairman at the first lecture : Professor M. T. Smiley.

Friday, May 13, at 8.30 p.m.—Centenary Celebrations Address : "University College, London, and Medical Education," by Professor Sir John Rose Bradford, K.C.M.G. Chairman : Professor Sir George Thane. (Admission by invitation only.)

ROYAL SOCIETY OF ARTS.

Monday, May 9, at 8 p.m.—(Cantor Lecture). John W. T. Walsh, M.A., M.Sc., F.Inst.P., A.M.I.E.E., Senior Assistant, National Physical Laboratory, and General Secretary, Internation Commission on Illumination : " The Measurement of Light." (Lecture III.)

Wednesday, May 11, at 8 p.m.—(Ordinary Meeting.) — Professor William E. Dalby, M.A., F.R.S., M.Inst.C.E., Dean of the City and Guilds (Engineering) College, Imperial College of Science and Technology : " English Railways." Brig.-General Sir Brodie H. Henderson, K.C.M.G., C.B., M.Inst.C.E., will preside. (Dr. Mann Lecture, II.)

THE INSTITUTE OF METALS.

At the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1., on Wednesday, May 11, 1927, at 8 p.m. the Seventeenth Annual May Lecture will be delivered by Sir Henry A. Miers, F.R.S., on " The Growth of Crystals in Supersaturated Liquids."

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New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

10,090.—British Dyestuffs Corporation, Ltd. — Manufacture of N-diarul-sulphonyl derivatives of arylamine-sulphonic acils. April 12th.

9,959.—Evans, F. P.—Manufacture of dry preparations of pigment dyes. April 11th.

10,071.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of alkali nitrates. April 12th.

10,191.—Parrish, P.—Installations for recovering ammonia from ammoniacal liquor. April 12th.

10,085.—Rubber Service Laboratories Co. Manufacture of acetaldehyde. April 12th.

Specifications Published.

268,537.—Woodcock, W. G., Drescher, H. A. E., Beckett, E.G., Thomas, J., and Scottish Dyes, Ltd.—Dyestuffs.

268,845.—Dreyfus, H.—Manufacture of acetic acid.

268,877.—British Synthetics, Ltd., and Higgins, E. B.—Manufacture of arylides or orthohydroxy-carboxylic acids.

269,028.—I. G. Farbenindustrie Akt.-Ges. —Manufacture and production of chromic chloride.

269,046.—Negle, A.—Apparatus for ozonising air and converting it into nitric oxide.

Abstract Published.

266,607.—Double salts of calcium lactate with calcium halides; medicines.—Colman, J., 97, Lehderstrasse, Weissensee, Berlin.

Double salts of calcium halides with calcium lactate are formed by introducing 100 grms. of calcium lactate gradually into 62 ccs. of 10 per cent. hydrobromic acid, or

70 ccs. of 10 per cent. hydriodic acid heated on a water bath, cooling the resulting solution, and allowing it to stand until the whole solidifies. The double salts, which contain respectively two molecules of calcium lactate and one of calcium hydrogen lactate to one of calcium chloride, six molecules of calcium lactate and one of calcium hydrogen lactate to one of calcium bromide, and ten molecules of calcium lactate and one of calcium hydrogen lactate to one of calcium iodide, are useful in therapeutics.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

IMMURESCINE.

478,399.—Chemical substances prepared for use in medicine and pharmacy.—William Rayner, Chemical Laboratory, Hyde Heath, Amersham, Buckinghamshire. April 20th.

NEVISOL.

478,617.—All goods in Class 1 which includes chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives.—Montgomerie, Stobo and Company, Ltd., Victory Works, George Street, Bridgeton, Glasgow. April 20th.

CELOZE.

477,516.—Chemical substances, in Class 1, for use in the manufacture of polishes.—Harry Tompinson, trading as Celoze Products, Fern Villa, Worsley Road, Winton, Patricroft, Lancashire. April 20th.

APEX.

477,769.—Cellulose acetate in granular form, in Class 1.—Apex (British) Artificial Silk, Ltd., 100, Carpenter's Road, Stratford, London, E.15. April 20th.

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ASSUMPTIONS IN THE MEASUREMENTS OF HYDRATIONS OF SUBSTANCES IN AQUEOUS SOLUTIONS.

By JITENDRA NATH RAKSHIT.

Hydrations of solutes or their components in aqueous solutions have been determined by several investigators by various methods, which are as a rule based on more or less different assumptions. But it has not been properly comparatively discussed how far such assumptions are reasonable with reference to the recent studies in the contractions in solution which appear to throw some further light on the relationship between solvents and solutes, and therefore it seems quite worth while to consider them now.

(1). Armstrong and his collaborators (*Proc. Roy. Soc.*, 1906, 78A, 272; 1907, 79A, 564, 579, 586; 1909, 81A, 102; 1912, 87A, 582; *Jour. Chem. Soc.*, 1911, 99, 349, 371) determined hydration by the precipitation of solutes from solution by the introduction of another solute, by the change in velocity of reactions such as inversion of sucrose, and by the hydrolysis of methyl acetate by dilute acids with or without the addition of salts. These methods presume that the molecules of the two solutes or their molecular associations with the solvent do not react with each other in any way but only remain there as physical mixtures; the position as regards how the two solutes remain in solution does not seem to be quite clear now and more statements on them are needed. In any case the hydration figures obtained by these methods indicate more what happens when two solutes are introduced in a solvent than what is the case with a solution of any one of them. It has been argued that on the introduction of calcium chloride in a solution of sucrose ,the hygroscopic property and higher solubility of salt operates, resulting in the dehydration with regard to the effect of dilution on the velocity of the rate of inversion by hydrochloric acid; but for the very same reason, however, it should follow that the same hydrations would be more or less proportional to the comparative solubilities and hygroscopic properties. The following figures may be considered in this connection :—

Molecular hydration by Armstrong	Solubility in 100gms. of water at 15° (from Comey).	Calculated molecules of water required to dissolve one molecule of substance.	Other properties.
NH_4Cl, 10 H_2O	35.2	8.4	Non-hygroscopic
KCl, $10H_2O$	33.4	12.5	,,
NaCl $13H_2O$	35.9	9.0	,,
$BaCl_2$ $19H_2O$	34.4	33.6	,,
$CaCl_2$, $22H_2O$	66.0	9.2	Hygroscopic

It is quite clear from this table, when figures are properly compared, that the solubility and hygroscopic property could not allow full support to the following inference by Armstrong—" in view of the general character of the effect produced by salts, bearing in mind also that easily soluble hygroscopic salts, such as calcium chloride, have far greater influence than sodium chloride, for example, it appears justifiable to regard the acceleration as concentrated effect due to the withdrawal by the dissolved substance of a certain proportion of the water molecules, which thus became removed from the sphere of the action of the acid." The above table shows that the molecules of water required to dissolve one molecule of substance do not bear any proportion with the molecular hydrations found by Armstrong when figures for calcium chloride are compared with those of other salts. These investigations seem to have made no clear and good case, so far, to find out any relationship amongst each other of the properties of solubility, association with solvent, deliquescence, and efflorescence. The formation of high hydrates in solution of efflorescent hydrates of sodium carbonate and sodium sulphate goes much against the above presumption.

(2). The method based on abnormal lowering of freezing points of solutions (Jones and his co-workers, *Amer. Chem. Jour.* 1900 23 ,103; 1905, 34, 341. Smitz, *Zeit. Phys. Chem.*, 1902, 39, 385. Biltz, *Zeit. Phys. Chem.* 1902, 4, 217, 1903, 43, 41), assumes that the solutes " must take up a part of the water forming complex compounds with it, and thus removing it from the field of action so far as freezing point lowering is concerned." If molecular contraction indicate the molecular association of solvent and solute, then such phenomenon of abnormal lowering of freezing points should have been observed in cases of many non-electrolytes whose solutions gave contraction in the same direction. Since contraction in solution is general to many electrolytes and non-electrolytes it is reasoable to think that the association of solvent and soluts may not be the only cause to abnormally affect the freezing point of aqueous solutions.

(3). The method based on the solubility of gases, liquids, and solids in water, produced by the addition of electrolytes and certain non-electrolytes (Rothmund, *Zeit. Phys. Chem.*, 1900 33, 401; Philip, *Trans. Chem. Soc.*, 1907, 91, 714), considers that the solute molecules get associated with some of those of the solvents, leaving others free to behave and act as if they have nothing to do with the associated ones; but such assumption could be considered hardly justified since when the free solvent molecules are removed from the field the original ratio of molecular association will be disturbed and changed. Presence of some surplus molecules of solvent is required to retain the determined ratio of hydration. It is more probable that such experiments would give the indications for only relative associations of solvent molecules with those of the two solutes present in the field than what happens when only one of them is present. When more than one solute is introduced in a solvent the molecular association of any one of them may not represent what happens when the other is absent from the field. In a solution of mixture of two substances the molecular association of any one of them with the solvent is function of their masses present and of their comparative chemical properties with reference to the solvent. Thus the results obtained by the above method might not represent with certainty what the case is when one solute is present.

(4). The merit of the determination of hydration of ions by the measurement of change of concentration at electrodes caused by the transport of solvents with ions during electrolysis has already been noted (Rakshit, *Zeit. fur Elec. Chem.*, 1925, 31, 320); these results could only give association of solvents with ions taking part in the electric current and might not possibly represent what the case is with others.

(5). Although there is not enough data to arrive at a definite conclusion about the method of determination of hydration by the measurement of relative migration velocities of ions (Bredig, *Zeit. Phys. Chem.*, 1894, 13, 262. Kohlrausch, *Proc. Roy. Soc.*, 1903, 71, 348; Bousfield, *Proc. Roy. Soc.*, 1905, 74, 563; *Zeit. Phys. Chem.*, 1905, 53, 257; *Phil. Trans.*, 1906, A. 206, 126), yet it may be stated that the results obtained by this method would represent only the conditions of ions taking actual part in the passage of electric current and might not give any idea about those molecules or ions who do not take part in the conduction of electricity.

(6). The distribution method (Philip and Bramlay, *Trans. Chem. Soc.*, 1915, 107, 377, 1831; Sugden, *Trans. Chem. Soc.*, 1926 ,174) or the one by the determination of variation of partition coefficient of a neutral indicating substance between water and an immiscible solvent with the addition of substances in water hydration of which have to be measured. This method assumed that some of the water was attached to the solute as water of hydration and thereby removed from its rôle of solvents, and that the lowering of solubility afforded a direct measure of this "fixed" water, and it also assumed that the indicating substance was insoluble in the hydrated salt. Sugden had a few results which agreed with those determined by other methods, but there were several others which gave disagreeing results probably indicating the merit of the general assumption that the associated molecules of solvent and solute do not dissolve the indicating substance under the conditions of the experiment. If molecular contraction is a function of solvent and solute the proposal of Sugden—that the figures obtained by this distribution process as hydration of some particular salts may be regarded as fixed values for all dilutions—becomes inconsistant. The molecular contraction varies with dilution indicating the change of association of solvent and solute. The abnormal behaviour of chlorates and nitrates of potassium was explained by stating that the solution of these salts exert a greater solvent powe rupon acetic than does pure water. If this explanation is to be accepted then it may just suit the reverse one for the salts, that is, the solutions of other salts exert a lesser solvent power upon acetic acid, and are not free from action at all.

It has been practically presumed in all the above cases of solutions containing two solutes that the associated molecules of solvent and solute are present there as somewhat like a mechanical mixture. It has not been made certain why these associated molecules do not interact or dissolve amongst each other and have a second effect of solution just as any of the solute does with the solvent. Probably the theory of solution of two solutes in the same solvent and solution is much more complicated than what have been described.

Government Opium Factory ,
Ghazipur, U.P.,
India.

A SELECTIVE DISPLACEMENT OF 0.0153A IN X-RAY SPECTRAL LINES. PART V.

By F. H. Loring.

Continuing from page 194 of the *Chemical News*, 1927, CXXXIV., it may be of interest to note in brief whether the displacement value is derivable from other spectral sources than those so far studied.

Since Δ_H is 16 times smaller than Δ_{He}, as here represented, it occurred to the writer that Δ_a (the displacement value in question) might be n times smaller than Δ_H (n being a whole number), that is, as here represented.

Calculating the values involved in relation to Δ_H and Δ_{He} according to established formulæ :— $\Delta_H = (R_H \times \alpha^2)/16$, when $\alpha = (2\pi eE)/(hc)$—the well-known *fine-structure constant.*

Taking c as 2.99796* (vacuum) $\times 10^{10}$; the air-value being 2.99729* $\times 10^{10}$, according to A. A. Michelson's new determinations (*Astrophys. Journ.*, 1927, LXV., p. 1).

e = 4.769 to 4.779) $\times 10^{-10}$ E.S.U., being Millikan's determination. $e = E$. 4.779 used.

* The error is *plus* or *minus* 0.00004.

R_H = 109677.70 *plus* or *minus* 0.04

$h = 6.55 \times 10^{-27}$. The left-hand value varies, say, from 6.545 to 6.557—the mean being 6.551. Selecting 6.55×10^{-27} as a *starting* value, the *final* value is 6.556×10^{-27}, when making use of the relationship previously given in this connection (see Parts I. and II.).

$$\Delta_a = 0.0152532.$$
$$\Delta_H = 24\Delta_a = 0.366076.$$
$$\Delta_{He} = 16\Delta_H \text{, as already known.}$$

Paschen's value for Δ_H = 0.3645 *plus* or *minus* 0.0045 (sometimes given as 0.365). It will be noted here that two values above are extended well into the decimal region as the calculations were carried out accordingly, but this does not imply that the final figures are anything more than closely approximate evaluations. It is possible that some of the constants used will be slightly revised in the near future.

That the above relation holds true rests entirely on the coincidence of numbers, as no rational basis for the agreement can be given as yet. All that can be said is : the various close evaluations, including the one above, are very nearly the same magnitude; to wit, 0.01527, 0.015258, 0.015220 (from the X-ray values only on page 193,

working out an average value), 0.01525, 0.015253; the mean or average value being 0.015250. There is danger, however, of pressing multiple relations of the above kind too far, but it comes within the scope of this series of studies to draw attention to such matters. It may be objected that ΔH is not altogether a comparable quantity as used here.

Referring to Part IV., the writer does not attach importance to the " Mo lines " being interpreted as displaced lines since the agreement is not good enough in respect of the $K\alpha_1\alpha_2$ lines taken in mean. This was intimated on page 193, but not stressed.

MINOR CORRECTIONS. — Vol. CXXXIV., p. 130., 2nd column : " Jean's " should read " Jeans' "; p. 144, in Notes : " settling ' 'should read " setting."

STANDARDISATION OF TITANOUS SULPHATE SOLUTIONS.

By WILLIAM M. THORNTON, JR., AND ARTHUR E. WOOD.

Department of Chemistry, The Johns Hopkins University, Baltimore, Md.

(Abstracted from a Report from " Industrial and Engineering Chemistry," — American Chemical Society.)

Titanous sulphate and titanous chloride are among the most useful reagents for quantitative analysis by reduction.

Some modifications of the apparatus of Thornton and Chapman for the storage and use of titanous sulphate are discussed, the degree of stability of the solution thus stored is indicated, and the suitability of potassium thiocyanate as an indicator is shown.

As a means of standardising the titanous salts a solution of ferrous ammonium sulphate, previously oxidised by potassium permanganate, has been suggested. As this method has been unfavourably criticised, several supposedly high-grade samples of this salt were purchased in the open market and tested.

Uncertainty as to the purity of the ferrous ammonium sulphate of commerce led to the examination of other materials. Sibley iron ore, as furnished by the Bureau of Standards with certified analysis, was found to be a satisfactory standard, and its use for this purpose is recommended.

Salts of trivalent titanium are among the most powerful reducing agents which have been proposed for analytical work, and their use in volumetric analysis is becoming more general for both organic and inorganic substances of many kinds. As a result, a good deal of interest has been taken in finding simple and accurate methods for standardising solutions of titanous salts.

Knecht in 1903 suggested as a standard a solution of a ferric salt of known strength, and many other workers have used various ferric compounds. Knecht stated that, although ferric alum might conveniently be used, its purity could not always be relied on. He therefore preferred ferrous ammonium sulphate of known concentration oxidised with nitric acid, or preferably with permanganate. Atack mentions " specially pure " ferrous ammonium sulphate as a standard, but states that it is difficult to obtain and keep a reliable supply of this salt, guaranteed samples sometimes containing 1 per cent. less than the theoretical quantity of iron.

Efforts have been made to find other substances which might serve as standards for titanous salts, either for general use or for special purposes. Thus Rhead for copper analysis standardised his solution with recrystallised copper sulphate. Radiberger and Siegmund for sugar analysis used copper sulphate whose value had been determined electrolytically. Atack, for the analysis of various substances, standardised against methylene blue which he proposed to evaluate by means of potassium chlorate.

For the analysis of aromatic nitro compounds (and this is applicable to other organic compounds which may be analysed by the same technic) English and Callan and Henderson advised *p*-nitroaniline as a standard. The method used, however, makes this an empirical standard, and the fact that English found his results to differ slightly from those he obtained when he standardised with ferrous ammonium sulphate should not be construed as an objection to the use of ferrous ammonium sulphate as a standard. The process of standardisation differed in technic depending upon the substance used. With *p*-nitroaniline some extraneous oxidation occurred, but by means of a blank experiment it would be possible to determine the extent of such oxidation and to correct for it. The values obtained against ferrous ammonium sulphate would then be correct and this salt, if pure, could be the standard for such analyses as wel las for widely different ones. In other words, an absolute rather than an empirical standard may thus be used.

Thornton and Chapman used ferrous ammonium sulphate which had been prepared by dissolving in water and precipitating with alcohol. A known sample was titrated

just to the end point with permanganate which, in turn, had been standardised against Bureau of Standards sodium oxalate. The solution was boiled, cooled, and titrated with titanous chloride. Another sample was titrated with the titanium solution without first oxidising wih permanganate. This gave the data necessary for calculating the value of the titanium solution in terms of either the ferrous ammonium sulphate or the sodium oxalate. The first titration with titanium gives the value in terms of ferrous ammonium sulphate. Correcting this titer by subtracting the small quantity used in the second titration gives the value in terms of sodium oxalate. The values calculated against the two standards checked very closely. This method can be regarded as strictly accurate, however, only when the ferrous ammonium sulphate is free from basic salts. Otherwise the titration showing the quantity of ferric iron present would be too low, as the basic ferric salts do not dissolve in cold dilute sulphuric acid readily and would thus be likely to escape determination, in part at least.

Hendrixson and Verbeck found the end point electrometically when the titanium solution was titrated against either permanganate or dichromate, directly or by means of a ferric salt solution, but in no case do they give the primary standard. Kolthoff and Tomicek mentioned as standards potassium dichromate, potassium ferricyanide, potassium iodate, potassium bromate, and ferric alum. They tried all except the halogen salts in their electrometric titrations. Only the ferric alum seems to be generally applicable as a standard. The other two, being coloured solutions, could not well be used where the end point is to be determined by a colour change rather than electrometrically. Moreover, as they showed, the ferric alum, in order to become a satisfactory standard, should be dried under definite vapour pressure conditions. Zintl and Rauch suggested that dichromate is not satisfactory for electrometric titrations if the titanous chloride is strictly pure but that ferric salts or copper salts are satisfactory. For titrations of bismuth they showed that the titanium solution must be standardised against bismuth.

Although Knecht and others have shown that ferrous ammonium sulphate oxidised with permanganate is a satisfactory standard, provided it is pure, Atack has pointed out that its purity cannot be assumed. It seemed worth while, therefore, to test this salt obtained in American markets for its suitability as a primary standard for titanium solutions, and, if it should not prove satisfactory, to try to find some substance which would be.

SUMMARY.

With a carefully set up apparatus of proper design it is possible to keep a solution of titanous sulphate for at least 3 months with very slight change in its iron value. This value should, however, be checked occasionally. Checking may probably be done most easily by keep on hand a solution of ferric alum, the exact iron value of which need not be known.

Apparently the less rubber tubing used between the storage bottle and the buret the better. The cause of the harmful influence of the tubing has not been definitely determined, however.

Potassium thiocyanate may be successfully used as an inside indicator, for the determination of iron at least. From 1 to 10 cc. of a 10 per cent. solution may be used, 5 cc. being enough. The end point is a little easier to determine when 5 cc. are used than when only 1 cc. is used.

Ferrous ammonium sulphate bought in the open market cannot be relied upon to serve as a satisfactory primary standard for titanous sulphate solutions. The same is true of the ferric oxide tested in the experiments here discussed.

Sibley iron ore as put out by the Bureau of Standards with analysis appears to be a reliable primary standard for titanous sulphate solutions. It may be prepared for titration without a great expenditure of time or effort.

Ferric alum, its oxidation carefully made complete with permanganate, is a very satisfactory secondary standard. Even if another ultimate standard is used, a solution of ferric alum is convenient for occasionally checking the permanence of the titanous solution and quantitatively measuring any changes it may undergo, even though the exact iron value of the ferric alum is not known.

DEATH OF PROFESSOR A. MIETHE.

It is reported from Berlin that Professor A. Miethe died on May 5, at the age of 66. Professor Miethe, it will be recalled, recently claimed to have succeeded in converting mercury into gold in detectable amounts. His results have not yet been confirmed, but should not be hastily discredited. He also contributed to the applications of photography in astronomy.

RECENT ADVANCES IN ELECTROCHEMISTRY.

Increasing Use of Electric Furnaces Calls for Better Refractories Methods for Making Purer Metals Insoluble Anodes and New Methods of Overcoming Corrosion.

By COLIN G. FINK, New York, N.Y.

(*Continued from Page 279.*)

A very interesting development is electrolytic iron. If years ago anyone had suggested the commercial production of iron by an electrolytic process, he would have been ridiculed. One of the electrolytic iron processes was started at the University of Wisconsin by Charles F. Burgess, whose dry battery you are acquainted with. In the French Boucher-Bouchayer process, iron is deposited on a steel mandrel, about 5 in. diameter and 10 ft. long. After attaining a certain thickness, the deposit is freed from hydrogen by slight heating, then passes through rolls to extend the circumference a trifle and then the tube is slipped off the mandrel, which is then ready for a new deposit. The Niagara Electrolytic Iron Co. has a large plant at Niagara Falls. The Western Electric Co. produces electrolytic iron at its plant at Hawthorne, Ill., and makes good use of its property of being brittle before the hydrogen is removed. The iron is deposited on a steel cathode to a thickness of about 3/16 in., and is then knocked off with a hammer. The pieces are ground to a fine powder, then mxed with shellac and some zinc oxide, and finally compressed into rings for the Pupin coils.

Another metal which has undergone considerable improvement within the last few years is nickel. Nickel, like iron, is very readily affected by the presence of hydrogen and the familiar peeling-off of nickel plating is due largely to the presence of hydrogen. Working with C. P. Marsden for a number of years, we came to the conclusion that if we could control the hydrogen at the cathode, we ought to be able to build up a heavy plate and produce malleable nickel. We tried out a number of different additions to the nickel sulphate bath and finally found hydrogen peroxide to be the best addition to counteract the hydrogen at the cathode. The hydrogen peroxide reacts with hydrogen to form water. The nickel produced under these new conditions, although it still seems hard, is very ductile. It is now possible to turn out large malleable sheets of nickel directly and very cheaply. The old process of melting down the metal casting it into squares and then rolling these into sheets is a difficult and expensive operation, whereas the electrodeposition of large malleable sheets is comparatively simple. The International Nickel Co. has this past year put on the market seamless nickel tubes made from pure electrolytic nickel. This has been quite an accomplishment, and the seamless nickel tubes are very resistant to many corrosive solutions met with in chemical engineering.

In the metallurgy of copper, there have been two very important developments, one is selective flotation and second, the development in leaching and electrodeposition. Formerly most of our copper was mined by digging holes underground, but in recent years this mining scheme has changed entirely. The big mining operations to-day deal with deposits containing less than 1½ per cent. copper, and if you have visited the plant of the Utah Copper Co., or the New Cornelia plant at Ajo, Ariz., or the plant at Chuquicamata, Chile, you have seen that underground mining has given way to a new method. At the Utah Copper Co., the whole mountain is shovelled into tanks and the copper leached out. At the plant at Chuquicamata, about 120,000 tons of ore is leached per day. The Utah deposit and the big deposits which are opening up in Africa contain carbonate of copper, with sulphide at depth. These deposits are now furnishing a great part of the copper of the world. The leaching of ore has brought about a number of new problems; first of all tank construction. We have been accustomed to using tanks built of wood. The tanks we see to-day are built of concrete and lined with asphalt. If you see the tanks from a distance they look very much like a group of buildings. So-called mastic lining is used, being reinforced with expanded iron. It is applied to the surface of the concrete, protecting it from dissolution. These large tanks presented an interesting problem for the engineers to solve.

Another problem with which we were confronted, was to find an insoluble anode resistant to a solution containing sulphuric, nitric, and hydrochloric acid. In the presence of sulphates, sodium nitrate, and considerable quantities of chloride, lead is readily soluble in the solution and 65 lb. of lead anode is lost for every 100 lb. of copper deposited. The problem was to find an anode which was insoluble in the three acids, sulphuric ,nitric, and hydrochloric. There are at the anode, two fundamental reactions : (1) the formation of the metal

sulphate, nitrate, or chloride by the direct combination of the anion with the metal of the anode, (2) the reaction of the anion with water to form acid and oxygen gas. By making the second reaction infinitely faster than the first, the anode becomes insoluble. From our old college training, we knew that lead peroxide and manganese dioxide favour the formation of oxygen. The anode as it is used to-day in the large electrolytic plant at Chuquicamata is composed of copper and silicon, together with small quantities of iron, lead, manganese, and tin.

Zinc has followed the footsteps of copper very closely. The old retort is disappearing. Electrolytic zinc is to-day produced at five large plants; the largest at Anaconda, another large one at Trail and a third large one at Risdon, Tasmania. Electrolytic zinc is of exceptionally high purity and is very resistant to corrosion. At Columbia University we recently investigated the leaching of zinc ore. E. W. Hale and myself carried out tests on chlorination and we discovered, much to our surprise, that the addition of a trace of bromine to the chlorine speeds up the reaction tremendously. Large scale tests have been carried out at The Dorr Co.'s laboratory and we are now interested in getting the process tried out at one of the large zinc plants.

The subject of corrosion came up very prominently during the war and we have really never lost sight of it ever since. The cost of steel structures has gone up by leaps and bounds, and the problem of preserving these structures from corrosion is a very urgent one. One of the schemes which has found application is the one which was tried out on a large scale in the British Navy. The boiler or condenser tubes are made cathode by externally applied electromotive force and anodes are introduced through the boiler shell at suitable points, the anodes, of course, being insulated from the boiler shell which is to be protected. Not only has the corrosion of the boiler shell and condenser tubes been entirely eliminated, but the formation of boiler scale, a problem equally as serious as the corrosion problem, has been eliminated. The system used here in the United States is the so-called Kirkaldy system. It has been tried out successfully by large concerns such as Stone & Webster, the Colgate Manufacturing Co., and others. One objection that has been brought up against the electrolytic protection system is the fear that with externally-applied electromotive force, large quantities of hydrogen would be evolved, and might embrittle the steel. As a matter of fact, less hydrogen is produced with the system than without. It will be appreciated that iron cannot go into solution without the evolution of hydrogen; for every gram of iron going into solution an equivalent amount of hydrogen is produced.

With the electrolytic corrosion theory in mind, we worked out a process at Columbia, together with Mr. Eldridge, on the restoration of ancient bronzes. Many of these bronzes, during the hundreds and thousands of years they were embedded in the soil, have corroded and become only a mass of copper carbonates. By reversing the current and making the bronze object the cathode, it was possible to restore the outline and, in many cases, the very fine details. If a metal core exists it bears none of the outline of the original casting as the details of the design are carried by the crust and not by the core. The solution we use is a 2 per cent. sodium hydrate solution. Any other solution, even a weak cyanide solution, produces local action on the bronze and destroys the detail. The bronze is hung in a cell, placing lead anodes on all sides of the bronze, and the electrolysis is allowed to go on for 3 to 6 weeks. In some cases the bronze was in the electrolyte for 2½ years. The copper is reduced in the outer shell and this keeps moving inward, just as in the series system of copper-refining. In order to prove our theory and process, a sample of natural malachite mineral was hung as the cathode in the same solution. The malachite was reduced to metallic copper in well-defined layers.

The subject of corrosion has interested us in other fields, for example, in the plating of chromium. Using the slogan of the painter, "if you protect the surface you protect all," we have devoted considerable time to protective coatings for steel and other metals. There are displayed on the table a number of chromium-plated samples. Chromium as seen here in a large mass is one of the most resistant metals I know. I have taken samples of pure chromium metal and put them in molten zinc, molten tin, molten brass (and I know of no liquid more corrosive than tin at 1500 deg. C.) and the chromium metal came out unscathed. Now the advantage of chromium as against zinc, which is used for the protection of steel, is that chromium has a much harder surface. It is the most resistant covering for steel, and some of the most expensive

yacht fittings have been chromium plated. The possible applications of chromium plating are numerous, and new uses are found every day. Chromium provides the best coating for high temperatures, for hard wearing surfaces, and for protecting steel, brass, copper and other metals from corrosion.

A CONTRIBUTION TO THE STUDY OF THE NUMBER OF TESTS REQUIRED TO ESTABLISH THE RUPTURING CAPACITY OF AN OIL CIRCUIT-BREAKER.

By E. B. WEDMORE, W. B. WHITMORE, B.Sc. (Eng.), AND C. E. R. BRUCE, M.A., B.Sc.

(*Before the Institution of Electrical Engineers.*)

SUMMARY.

The paper is based on an investigation of the degree of variation of results obtained in repeat tests in the simplest case of a single-break circuit breaker and fixed conditions of supply.

It is shown that the difficulty of rating a circuit breaker is closely analogous to the difficulty a student would have if asked to determine the tensile strength of a specimen on a testing machine in which a concealed fulcrum of the lever system is moving in an unknown manner and varying the leverage over a range of the order of, say, 1 to 50.

Curves are given, based on a large mass of data, showing the way in which the maxima and means of arc energy in groups of repeat tests vary, and startling conclusions are drawn as to the prohibitively large number of tests necessary to establish a rating with any reasonable degree of accuracy by the generally accepted commercial methods of testing.

The investigation also throws light on the probable cause of the mysterious failures of circuit breakers that have been reported from time to time.

On three-phase work a slight reduction in the number of tests may be allowed, but this does not materially affect the general conclusion that the number necessary would be prohibitively large.

A thorough investigation of all possible causes of variation, and the development of formulæ and the determination of constants by test, appear to be the true solution of this important and pressing problem.

General Notes.

RESEARCH SCHOLARSHIPS IN TECHNOLOGY.

The governing body of the Manchester Municipal College of Technology, (University of Manchester), offers a limited number of Research Scholarships in Technology. The value of the scholarship will not exceed £100, and will be tenable during the Sesssion 1927-28 in the College.

Research may be undertaken in any of the following departments :—

Mechanical Engineering,
Electrical Engineering.
Municipal and Sanitary Engineering.
Applied Chemistry :—
(*a*) General Chemical Technology.
(*b*) Chemistry of Textiles (Bleaching, Dyeing, Printing and Finishing).
(*c*) Dyestuffs.
(*d*) Fuels.
(*e*) Paper Manufacture.
(*f*) Metallurgy and Assaying.
(*g*) Chemical Technology of Brewing.
(*h*) Electro Chemistry.
Textile Industries.
Photographic Technology.
Printing.
Industrial Arministration.

COPPER, ZINC AND LEAD PRODUCTION IN CANADA, 1926.

The Dominion Bureau of Statistics at Ottawa reports that copper production from Canadian ores during 1926 amounted to 132,345,152 pounds valued at $17,386,867. In 1925, production computed on a slightly different basis, as explained below, totalled 111,450,518 pounds valued at $15,649,882. Copper is produced in the provinces of British Columbia, Ontario and Quebec. British Columbia accounts for about two-thirds of the total Canadian output and Ontario most of the remaining one-third. A smaller amount is produced in the province of Quebec from the Eustis mine, but large deposits are now being opened up in the new Rouyn district of this province and in the near future Quebec will enter the field as one of the large Canadian copper-producing provinces.

ZINC.

Computed in this manner the total production for 1926 was 161,897,466 pounds which at 7.41 cents per pound (London quotations) was valued at $1,996,691 as compared with 109,268,511 pounds produced in 1925 with a value of $8,328,446 when the average price was 7.622 cents per pound (St. Louis). The average London price in 1925 was 7.966 cents per pound.

LEAD.

Canada's total production in 1926 amounted to 248,120,946 pounds and thus was worth $19,262,242 as against 253,590,578 pounds produced in 1925 and valued at $23,127,460, on the basis of 9.12 cents per pound, which was the average of the Montreal quotations for the year. The London price in 1925 was 7.914 cents per pound.

THE GOLD STANDARD AND FALL IN WORLD PRICES.

As it is now two years since Great Britain returned to a gold standard, it is generally assumed that any adverse influence which that step may have had on our trade must have long since passed away. This is so contrary to the truth that we feel no apology is needed for once again drawing attention to the serious obstacles to industrial progress which still exist as a consequence of the conditions under which that return was made (says *Supplement to British Industries*).

Looked at from the point of view of British manufacturers, the injury caused to industry by the reversion to gold may be said to have come principally from two inevitable consequences of that step. In the first place, the re-linking of our currency to gold meant that the level not only of our home prices but—if we may assume that Great Britain is still the principal international financial centre—also of prices in the principal international markets, was once more made to fluctuate with variations in the gold supply, or, what amounts to much the same thing, the condition of credit in the British money market. In the second place, since the return to a gold standard was accomplished by a more or less arbitrary forcing up of the value of the £ sterling on the foreign exchange, it necessitated a corresponding downward adjustment of British costs of production and selling prices ,if our exporters were not to be at a disadvantage in competing with their rivals.

LINDSAY, ONTARIO, BECOMES CHEMICAL INDUSTRIES CENTRE.

A "continuous system" industrial alcohol plant, with an annual capacity of 1,000,000 gallons, has been recently placed in operation by the Lindsay Industrial Alcohols ,Ltd. Ample room has been provided to double the capacity. The plant has storage capacity for 100,000 gallons of molasses and 85,000 bushels of grain.

Located on the Trent Valley Canal, it has transportation facilities for raw materials and finished products by both rail and water. The company has also acquired the properties and equipment of the Hodgson Bros. Chemical Co. ,Ltd., and will continue producing methyl alcohol, charcoal, and acetate of lime.' It is also planned to instal equipment for refining methanol and for manufacturing formaldehyde.

CANADIAN CELANESE STARTS ITS LOOMS.

The looms of the Canadian Celanese plant at Drummondville, Quebec, have been started, and it is expected shortly to supply the Canadian trade with celanese textiles woven in Canada. As soon as possible the company will break ground for its chemical acetate plant, when this addition is completed, the entire process of spinning, weaving, dyeing, finishing and printing the celanese yarns and fabrics will be carried out at Drummondville.

GAS IN THE HOME.

MARKED ADVANTAGES CLAIMED OVER COAL OR ELECTRICITY.

The important structural economy that can be effected by the installation of gas fires in place of coal grates in new houses was the theme of an interesting lecture delivered at Liverpool to the Society of Builders by Mr. W. L. Stringer, of Messrs. John Wright & Co., Ltd., Birmingham.

Dealing with the heating requirements of the dwelling house, Mr. Stringer pointed out that gas appliances adequately fulfilled every conceivable purpose—cooking, room-warming and water-heating. The matter, he said ,was one of prime importance to the architect and the builder because it involved among other things questions of costs, construction and ventilation.

It was necessary that living rooms should be efficiently ventilated for the sake of the

health of the occupants. The domestic chimney offered an effective means of ventilation, but equally good results could be obtained from a smaller flue. If gas grates were installed these could be used in conjunction with a flue composed of hollowed-out "economy" blocks, which provided a passage sufficiently large to carry away the products of combustion, and ensure a sufficient number of changes of air to keep the room healthily ventilated. This method saved floor space and greatly simplified chimney and hearth construction and meant a reduction of building costs.

On the question of kitchen coal-burning appliances, Mr. Stringer declared that they could be effectively replaced by the gas cooker, the gas wash boiler, and the gas circulating boiler, and a considerable saving in space and cost could be effected by their use. The cost of gas compared favourably with that of coal, while it was much below that of electricity. Gas was also a great labour-saver, and in this respect far superior to coal or electricity .

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

Thursday, May 5.

The Nature of the Alternating Effect in Carbon Chains. Part XVIII. Mechanism of Exhaustive Methylation and its Relation to Anomalous Hydrolysis. By W. Hanhart and C. K. Ingold.

The mechanism proposed in connection with anomalous hydrolysis is applicable to exhaustive methylation and to the decomposition of quaternary ammonium compounds generally. In particular it accords with the formation of olefines in the absence of α-hydrogen atom and it embraces the generalisation that ethylene is preferentially eliminated. It defines and explains the conditions governing the replacement of olefine elimination, the "primary reaction," by the elimination of methyl or another alcohol.

The inter-Relationships of the Sulphuric Acids. By H. Bassett and R. G. Durrant.

The hydrolysis of sulphur probably takes place in accordance with the reaction $S_2 + 2HOH \rightleftarrows H_2S + S(OH)_2$. The sulphoxylic acid cannot be isolated because it readily decomposes to yield hydrogen sulphide and sulphurous acid. This decomposition has been shown to occur both in acid and alkaline solutions by experiments with sodium formaldehylesulphoxylate and with sodium hypohulphite. Formation of sulphoxylic acid is considered to be the first step in the Wackenroder reaction.

Thiosulphuric acid decomposes in three different ways:—(*a*) to yield sulphurous acid (or probably sulphonic acid) and sulphur according to the bimolecular reaction $2H_2S_2O \rightleftarrows 2H_2SO_3 + S_2$, (*b*) to yield hydrogen sulphide and trithionic acid and (*c*) to yield an anhydro-acid $H_2S_4O_5$. Decomposition according to (*b*) is considered to be the fundamental reaction by which polythionates arise—both in acidified thiosulphate solutions, and in the Wackenroder reaction, whilst trithionic acid is considered to be the primary thionic acid. The higher thionic acids are formed from trithionic acid by addition of sulphur, the chief sulphurising agent being thiosulphuric acid.

All the decompositions of thiosulphuric acid proceed with diminution of acidity. Formation of the anhydro-acid $H_2S_4O_5$ corresponds with the removal of about half the acidity and to its formation is due the somewhat paradoxical result that thiosulphate is apparently much more stable in very strongly acid solution than in moderately acid solution. The acid $H_2S_4O_5$ has a strong reducing action on methylene-blue. indigo ,etc., being itself oxidised to tetrathionate. The cause of the colour of certain simple inorganic sulphur compounds is considered and attributed to the presence of a sulphur atom with a ten-electron sheath.

The Constitution of the Disaccharides. Part XIV. Melibiose and its Relation to Raffinose. By W. Charlton, W. N. Haworth, and W. J. Hickinbottom.

Zemplén (*Ber.*, 1927, LX., 923), has advanced new constitutional formulæ for melibiose and raffinose differing from those which had previously been assigned to these sugars by Haworth. On the basis of Zemplén's formula, methylated melibiose should give rise on hydrolysis to tetramethylgalactose and to 2 : 4 : 6-trimethylglucose. Completely methylated melibiose leads on hydrolysis to the isolation of crystalline tetramethylgalactose and to 2 : 3 : 4-trimethylglucose. The latter sugar was converted to the crystalline 2 :3 :4-trimethylβ-methylglucoside, identical with that isolated on previous occasions from methylated gentiobiose, methylated amygdalin, and

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methylated raffinose. Haworth's structural formula for melibiose is therefore substantiated by these results. In both melibiose and raffinose the galactose residue is attached to the glucose residue through position (6) in the glucose chair. Other evidence is communicated which shows that melibiose is probably not a β-biose, and the suggestion is made that the disaccharide is of the α-type.

THE ROMANCE OF THE ORGANIC CHEMICAL INDUSTRY.

By E. Frankland Armstrong, D.Sc., Ph.D., LL.D., F.R.S.
(*Managing Director, British Dyestuffs Corporation Limited.*)

Before the Royal Society of Arts.

Abstract.

That Science, even Chemical Science, has its romantic side is a fact which needs no argument before an audience composed of Fellows of the Society of Arts, but you will be more inclined, perhaps, to associate the Chemical Industry with the all-important, though prosaic, subject of Balance Sheets, Dividends, pollution of the atmosphere, and other necessary evils of the factory. Yet, as I shall endeavour to show there is very distinctly a romance being played in our history.

The world as we know it contains certain crude or raw materials of little use to man as such, but capable of being elaborated in the industries to produce the thousand and one things which we regard as indispensable to-day.

Now let us consider some of these selecting our examples solely from the point of view of the chemist, and limiting the choice still further so as to confine it to organic materials, which, as you know, are those containing carbon atoms in their structure, and see what can be made from them. Obvious choices for our study are coal, petroleum, cellulose in its many forms —for example, wood, cotton and other fibres—and starch in the form of cereals. It is true that these particular materials form the basis, without much elaboration, of most important products, but we shall see how the chemist is able to elaborate from them products which but a generation ago were mainly laboratory curiosities, though to-day, they are, or are about to be, produced in such quantities, and at such price, that they enter largely into the comfort of every citizen.

The story of the colour industry, of the winning of synthetic dyes from coal tar, has been told so often that I propose rather to select this evening another example of chemical achievement and to discuss the alcohols—the "aliphatic alcohols," as the chemist terms them.

Alcohol itself, ethyl alcohol, requires no introduction. As a product of fermentation its uses have come down to us through the ages described in prose and song; to-day it forms one of the most popular means of providing the national revenue. It is as a solvent that we consider it now, though, unfortunately, in use, the necessary restrictions imposed by the Customs and Excise will never let us forget its more conventional application. Alcohol is made by fermentation of grain, of potatoes, of molasses —all raw materials which are subject to the usual variations of the market, but which have a minimum price as they are also of value as foodstuffs.

Methyl alcohol, the next most important alcohol in commerce, is one of the products of the wood distillation industry. Its price has been subject to wide market fluctuations, according to the laws of supply and demand, and the general state of the wood distillation industry. As is well known, the chemist has accomplished recently the synthesis of methyl alcohol from carbon monoxide and hydrogen, by passing the mixed gases under great pressure over a suitable catalyst at a high speeed. In consequence, unlimited quantities of methyl alcohol are available, derived from coal or coke at a cost which is probably less than 20 per cent. of what it used to be. When new uses are found for the alcohol, either as a motor fuel or as a solvent, the price to the consumer can be lowered to make such uses attractive.

Butyl alcohol was for many years only a product of the laboratory, until it was produced in quantity as an unwanted by-product in the manufacture of acetone by fermentation. Uses were sought for the butyl alcohol which accumulated in this way; finally it was found that the butyl acetate formed a nearly ideal solvent for nitrocellulose. The fermentation process was restarted on an industrial scale, this time with butyl alcohol as its aim, the proportion of acetone being restricted as much as possible. To-day, thousands of tons per annum are being manufactured from grain or rice, and sold at a price which, though high, is well within commercial practicability. But the new fermentation method

is being menaced before it is hardly established. The pressure process for methyl alcohol, when suitably modified in a manner which has not yet been disclosed, can be made to yield butyl alcohol said to be just as satisfactory as the fermentation product for use as a nitrocellulose solvent. There is yet another chemical process in sight, based on acetylene—that is, on carbide as raw material. Acetylene is converted into acetaldehyde in the manner to be described when dealing with acetic acid. From acetaldehyde, by a series of reactions involving condensation and reduction, the two-carbon chain compound is converted into one with four carbon atoms, again a butyl alcohol resulting, which is suitable for the lacques maker. The process is understood to be in operation on a large scale on the Continent, and to have commenced in Canada; the reactions involved proceed smoothly, and give good yields of pure products.

Yet another potential source of butyl alcohol is from petroleum. It is customary to-day to crack, that is, heat under pressure, a great deal of the crude oil produced so as to convert it into fractions suitable for use as a motor spirit. During cracking, considerable quantities of gas are produced, which, as a rule, are burnt in the cracking furnaces. Under certain conditions of cracking in the vapour phase, the gases contain ethylene, propylene, butylene, and similar hydrocarbons, and by absorbing these in sulphuric acid and subsequent hydrolysis and separation by distillation, the appropriate alcohols are obtained.

Butyl alcohol, undoubtedly, will be manufactured by the cracking process, though it has yet to be determined whether the product won in this manner has the same utility in the varnish industry as the fermentation product. I may remind you that even in so simple a product as butyl alcohol, containing four carbon atoms $C_4H_{10}O$, there are several ways of arranging the atoms so as to give different isomeric butyl alcohols :

$CH_3.CH_2.CH_2.CH_2OH$	=	normal	boiling at 117°
CH_3 $>CH.CH_2.OH$ CH_3		iso	boiling at 107°
C_2H_5 $>CH.OH$ CH_3	=	ethylmethyl carbinol	boiling at 101°
$(CH_3)_3.C.OH$	=	trimethyl carbinol	boiling at 83°

In practice, fermentation gives the normal alcohol, pressure methods the iso alcohol, and cracking a mixture of secondary and tertiary alcohols. From aldehyde the normal alcohol is obtained. Obviously, the difference in the boiling points will effect the utility of the isomerides.

The next higher alcohol is amyl alcohol, produced in a crude form as fusel oil to a limited extent in the distillery. A synthetic substitute will undoubtedly be produced by the pressure process—another is said to be made from pentane obtained from natural gas.

The alcohols whose production we have considered are used mainly as acetates, or, to some extent, as lactates and tartrates. Hence the production of acetic acid must also be taken within our survey. For many years, most of that used in commerce was obtained by the destructive distillation of wood. The crude grey acetate of lime was exported to Europe and decomposed with sulphuric acid, the crude acetic acid produced being purified by fractionation.

The alternative source was vinegar produced by fermentation. Usually a crude vinegar containing 10-12 per cent. of acetic acid is first made from potato spirit; this is neutralised with lime, evaporated, and of distillation enables the 10 per cent. solution to be concentrated in a still and obviates neutralisation. The quantity obtained in this way, mostly made from the refuse of the forests of Canada and the United States, did not suffice for the war requirements, and, consequently, alternative processes were evolved on a manufacturing scale. These involve the oxidation of acetaldehyde, prepared either from acetylene by the use of a mercury catalyst—

$$CH : CH + H_2O = CH_3.CHO$$

or from alcohol dehydrogenated in presence of a copper catalyst—

$$CH_3.CH_2.OH = CH_3.CHO + H_2$$

The former process was in use in Germany during the war and has been studied in particular in Canada, and brought to a stage of great perfection by the Canadian Electro Products Company, who manufacture acetic

acid by it in large quantities. The alcohol process was worked successfully in England during the war, no carbide being available; its chances as a competitive process depend on the cost of the alcohol.

Just as the prospect of cheap formaldehyde appears to lead far in many organic syntheses, the possession of cheap acetaldehyde bristles with possibilities. The addition to it of hydrogen cyanide, and subsequent hydrolysis, would result in a synthesis of lactic acid—

$$CH_3.CHO + HCN = CH_3.CH(OH).CN$$

which is at present somewhat laboriously made by a fermentation process. It is understood that this method is under study.

I have time for one other illustration, the production of phthalic acid, the esters of which are of prime importance as plasticisers. Until a few years back, phthalic acid was essentially a scientific curiosity, and its technical application unthought of. It was then discovered how to make it easily and at a surprisingly low cost by the catalytic oxidation of naphthalene, one of the commonest constituents of coal tar with air. At once, phthalic acid became a raw material for some of the most striking syntheses in the dye industry, namely, those of the anthraquinone or so-called vat dyes, which are the fastest colours known, and consequently, becoming every day of greater importance. Other uses were sought for it and found, one in the lacquer industry and another as the basis of an artificial resin, of altogether exceptional electrical properties.

ESTIMATION OF CHLORIDE IN PRESENCE OF FERROCYANIDE.

By Naoto Kameyama.

(*Department of Applied Chemistry, Tohoku Imperial University.*)

In course of an investigation on the membrane equilibrium (*Phil. Magazine*, Oct., 1925), the author had to estimate accurately a smal lamount, say 0.01 *N*, of chloride in presence of a fairly large amount, say 0.2 *N*, of potassium ferrocyanide. The method tried first was this: Ferrocyanide plus chloride is determined by titration with silver nitrate, using potassium chromate as indicator, and, in another sample of the same solution, the amount of ferrocyanide by titration with permanganate. The amount of chloride is given by difference of the two. The method was found liable of arriving at an under-estimation. An utmost care should be taken for the slow titration under constant stirring, using dilute solution of the mixture. Otherwise the silver titre is apt to go short, and the permanganate titre to go over. That the ferrocyanide is monovalent towards permanganate, while it is tetra-valent towards silver salt makes it still worse.

An attempt was made to estimate both chloride and ferrocyanide by a single electrometic titration with silver nitrate solution and silver electrode. Although the end point for the sum of chloride plus ferrocyanide was found to be sharp and accurate, the change over of that part of the titration curve corresponding to silver ferrocyanide Ag_4FeCy_6 into that of silver chloride (the former is less soluble) was not sharp enough.

In a similar titration with silver nitrate solution, it was also tried, but without success, to get the end point of the titration of silver ferrocyanide, by following the change of the oxidation potential of $FeCy_6'''/FeCy_6''''$ using a platinum electrode combined with an addition of a small amount of potassium ferricyanide, and then, by means of a silver electrode, to finish up to the end of silver chloride. The oxidation potential rises sharply at a point very near the true end of formation of Ag_3KFeCy_6, but beyond this point its course is rather irregular.

The method finally adopted was the following one. The ferrocyanide is removed by precipitation with zinc sulphate solution and the chloride estimated directly in the filtrate and washings. Decinormal zinc sulphate sodution is allowed to drop slowly from a burette into the solution kept stirred at 50-60° C. The solution and precipitate are allowed to stand at room temperature overnight, and then the precipitate is filtered off and washed with dilute zinc sulphate solution. The chloride in the mixed filtrate and washing is then titrated electrometrically with decinormal silver nitrate solution.

Neither the excess of zinc sulphate nor the potassium sulphate present in the solution was found to affect the accuracy of the result. Use of the distilled water for the washing of the precipitate of zinc ferrocyanide instead of zinc sulphate solution causes an over-estimation of chloride.

It was also attempted to utilise the precipitation of zinc ferrocyanide for the purpose of estimation of the ferrocyanide as

well as for the purpose of removing the same from the mixed solution. The change of oxidation potential of $FeCy_6''''/FeCy_6'''$ was followed electrometrically by means of a platinum electrode combined with an addition of a small amount of potassium ferricyanide. Although the end point of the ferrocyanide titration was found to be sharp and accurate, the estimation of the chloride in the filtrate gave result, which was a little too high, owing to the solubility of zinc ferricyanide.

NOTICES OF BOOKS.

Achema Jahrbuch.

We have received the *Achema Jahrbuch*, dated 1926-27. This almanac, edited by Dr. Max Buchner, has apparently been published for preparing the chemical world for the exhibition of chemical plant which will take place at Essen from June 7 to 19.

The book is divided into three sections—General, Scientific, and Technological—but is mainly concerned with chemical engineering.

The work runs into 317 pages and costs ten marks. It is obtainable from the Verlag Chemie G.m.b.H., Berlin, W.10.

The Natural History of Ice and Snow. (Illustrated from the Alps). By A. E. H. TUTTON, D.Sc., M.A., F.R.S. With 48 *full-page plates (174 figures)*, 16 text illustrations, and map. Pp. VIII + 320. Price 21s. net. London : Kegan Paul, Trench, Trubner & Co., Ltd.

This is an exceedingly instructive and interesting book, written by one who is obviously well acquainted with his subject, and competent to treat it in a manner that will be understood by the ordinary reader, while the scientifically inclined will also find matter to enlarge their outlook on many aspects of life. The illustrations are numerous and beautiful, most of them giving views of some parts of the Alps. After a glance at these pictures, one will cease to wonder at the fascination which mountain-climbing has for so many.

In the first part of the work, the evolution of our knowledge of water and ice, the physical relationship of water and ice, the crystal structure of ice and snow, optical, thermal and electrical properties of ice, plasticity, viscosity, and elasticity of ice and artificial ice production are dealt with in a manner calculated to instruct as well as interest the reader.

Part II. deals in the main with the Alps, the ice and snow mountains of Central Europe, nature and geological character of the Alps, situation of the ranges, peaks and glaciers of the Alps, snow caps and glaciers and their movements, crevasses, Bergschrunds and séracs, moraines and glacier lakes, and how the great summits have been conquered.

Part III. treats of the expeditions in the Bernese Oberland, in the Peninine Alps, and the Matterhorn, the Chain of Mont Blanc, the ascent of and scientific work on Mont Blanc, and expeditions in the various other Alpine ranges. It is a well-written and instructive book, one which will not readily become a back number and deserves and will doubtless receive a wide and sustained popularity.

FORTHCOMING EVENTS.

THE ROYAL SOCIETY.

Thursday, May 12, at 4 p.m.—Election of Fellows.

Thursday, May 12, at 4.30 p.m.—Discussion Meeting on "The Function and Distribution in Living Organisms of Hæmoglobin and Related Substances."

1. Prof. J. Barcroft, F.R.S. : "Recent Work on Hæmoglobin and Related Substances."
2. Dr. H. Hartridge, F.R.S., and F. J. W. Roughton : "Measurement of Velocities of Hæmoglobin with other Substances."
3. Dr. D. Keilin : "Cytochrome in Animal and Plant Cells."
4. R. Hill : "Structure and Preparation of Hæmoglobin and its Chemical Precursors."
5. Prof. H. Munro Fox : "Hæmoglobin Analogues in the Blood of Certain Polychæte Worms."
6. Dr. J. B. S. Haldane : "Effect of Carbon Monoxide on Plants and Insects Containing no Hæmoglobin."
7. Sir Frederick Hopkins, F.R.S. : "Some General Conclusions."

LONDON UNIVERSITY.

University College, Gower Street, W.C.1.

Monday, May 16, at 5.30 p.m. — "England and America, Their Relations in the Past and their Obligations to each other To-day." A public lecture by Mr. George Haven Putnam, Litt.D.

Tuesday, May 17, at 5.30 p.m.—" Air Power and Imperial Defence." A public lecture by Air Vice-Marshall Sir Philip W. Game, K.C.B., D.S.O. Chairman: Brig.-General The Rt. Hon. Lord Thomson, C.B.E., D.S.O.

Thursday, May 19, at 5.30 p.m.—Recital of Norwegian Songs by Guldberg's Norwegian University Men's Choir.

INSTITUTION OF ELECTRICAL ENGINEERS.

Wireless Section.—Wednesday, May 18, at 6 p.m.—" A Wireless Works Laboratory." By P. K. Turner.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Friday, May 20, at 9 p.m.—" The Structure of the Silicates." By Professor W. L. Bragg.

ROYAL SOCIETY OF ARTS.

Wednesday, May 18, at 8 p.m.—(Ordinary Meeting.) Robert R. Hyde, Director, Industrial Welfare Society: " Industrial Welfare in Great Britain and the United States." Sir Robert A. Hadfield, Bt., D.Sc., F.R.S., Member of the Council of the Society, will preside.

SOCIETY OF GLASS TECHNOLOGY.

Meetings will be held at University College, Gower Street, London, W.C.1.

Wednesday, May 18, at 7 p.m.—Annual Dinner at the Hotel Cecil, London.

Thursday, May 19—Morning Visit to the Lamp Works of the General Electric Co., Ltd., Brook Green, London, W.6.

Wednesday, May 18, at 2.40 p.m., at University College:—

1. " The Decomposition of Glass by Water at High Temperatures and Pressures." By Dr. G. W. Morey and Dr. N. L. Bowen., (Geophysical Laboratory, Washington, U.S.A.)
2. " The Brittleness of Glass." By Prof. G. Gehlhoff, Dr. Phil. (Osram G.m.b.H., Berlin.)
3. " The New British 15-Arm Automatic Suction Bottle Machine." By F. Redfern.
4. " Standard Durability Tests for Bottles."

Thursday, May 19, at 2.30 p.m.—The meeting will be devoted to a general discussion on Furnace Efficiency. In particular, the discussion will be continued on the paper presented by Prof. W. E. S. Turner to the April Meeting, namely: " A Brief Review of Furnace Developments."

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

10,858, 10,859.—Brightman, R., and British Dyestuffs Corporation, Ltd.—Azo dyestuffs. April 22nd.

10,852.—Chemische Fabrik vorm. Sandoz.—Preparation of gall acids. April 22nd.

10,647.—Commercial Solvents Corporation.—Catalysts for synthetic methanol production. April 20th.

10,827.—Gaillard, A.—Treating superphosphates. April 22nd.

10,861.—I. G. Farbenindustrie Akt.-Ges.—Increasing fastness to light of dyestuffs. April 22nd.

261,693.—Steffen, Junr., J. (deceased).—Processes for obtaining tricalcium saccharate.

269,302.—I. G. Farbenindustrie Akt.-Ges.—Manufacture and production of aromatic derivatives of formamide.

251,267.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of basic chromium salts.

165,149.—Oesterreichische Chemische Werke Ges.—Process for the production of persulphuric acid and its soluble salts from sulphuric acid by electrolysis.

266,820.—Synthetic drugs.—Stickings, W. R. E., The Rowans, Ravensbury Park, Mitcham, Surrey, and May and Baker, Ltd., Garden Wharf, Church Road, Battersea, London.

Basic bismuth salts of arylarsinic acids are prepared by heating in solution a bismuth salt with an excess of a salt of an arylarsinic acid. The products possess enhanced therapeutic properties. Preferably bismuth salts of hydroxypolybasic acids such as tartaric acid are employed, and convenientiy in the form of their soluble double salts with alkali metals. The excess of arylarsinic acid salt should not fall below 25 per cent., and may rise to 80 per cent.; the temperature is maintained above 30° C. to avoid gel formation and below 100° C., preferably at 70° C. Examples are given of

the preparation of the basic bismuth salts of N-phenylglycinamide-*p*-arsinic acid, *p*-aminophenlyarsinic acid, 3-acetylamino-4-oxyphenylarsinic acid, and 2-oxy-5-acetyl-aminaphenylarsinic acid by interaction of the sodium salt of the respective acid with sodium bismuthyl tartrate.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

OXYCARNOL.

478,289.—Chemical substances for use in the dyeing industry and in Class 1.—I. H. Th. Bohme Aktiengesellschaft, 29, Moritzstrasse, Chemnitz, Germany. April 27th.

RADIOSTOL.

477,932.—Chemical substances prepared for use in medicine and pharmacy.—The British Drug Houses, Limited, 16 and 30, Graham Street, City Road, London, N.1. April 27th.

HORMONAX.

475,694.—Chemical substances prepared for use in medicine and pharmacy.—Duerdin & Sainsbury, Limited, Bond Street, Melbourne, Victoria, Australia, and 61, Broad Street Avenue, 11, Blomfield Street, London, E.C.2. April 27th.

Outlines of an ABBREVIATED NOTATION IN CHEMISTRY

ROBERT SAXON, B.Sc., F.C.S.

(TYPEWRITTEN).

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A STUDY OF THE MINERAL COMPONENTS OF ORGANISED MATTER.

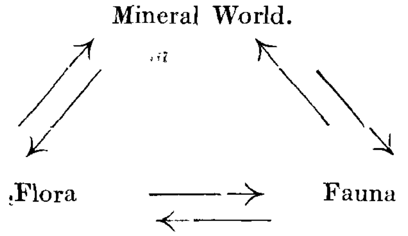
By MAURICE COPISAROW, D.Sc.

Perpetual motion, the ideal of the mediæval thinkers, is actually the most usual state of Nature in and around us. The universe, taken as a whole, including all worlds, being the perfectly closed system, the real unity.

Each organism, in the course of its lifetime, is renewed over and over again. Organised bodies, depending upon temperature and pressure, existing and retaining their specific properties from physical to purely psychical only within certain limits of these variables, by some strain of generalisation, can be regarded as a special form, namely, the fifth state of matter. Thus: (1) Ether, (2) Gas, (3) Liquid, (4) Solid, and (5) Organised Matter. There is no absolute rest in Nature. Matter is in a state of continuous transmission, passing through all its possible states and forms again and again, with certain variations in the order of succession.

Organised and unorganised matter on the one hand, and the animal and vegetable world on the other, are so intrinsically connected with each other, and their intercourse in the form of interchange of matter is so intimate and permanent, that to have a more or less correct image of the reality, we must, at least, glance for a moment on the whole world of matter as such.

So far as it concerns our planet, the transmission or transportation of matter can be graphically represented thus:—



The actual configuration of the circles of transportation is, by far, more complicated than represented here; they often intersect one another or even become concentric. In every one of these circles, representing respectively the inorganic, animal and vegetable worlds, the transportation of matter goes on in two directions, from lower or simple to higher or complex (development, aggregation, anabolism), and secondly from higher to lower (parasitism, disintegration, catabolism). This interchange is, of course, not at all confined within the limits of each individual circle or world; but on the contrary, the intercourse is most active amongst them. The transmission of matter, being in no case a simple transfer, is ac-

companied by a whole series of chemical physiological ,etc., reactions, and there is a more or less stable equilibrium of this metabolism depending ultimately, on such conditions as pressure and temperature, the general environment and consequently the relative mass of every world depending upon T and P.

Having before us, as a problem, the comparative study of inorganic components of organisms, we could, from the previous deliberations arrive at the conclusion that if the transmission of inorganic matter were a simple transfer, we might expect to meet any element and its compounds in every organism. But taking into consideration the fact that the occurring chemical combinations are subject to certain well-defined physiological laws, we can understand that excluding all adventitious matter, the number of elements and their compounds in the organism are not at all limitless.

The Mineral Matter of Animals.

The study of animal and vegetable matter has disclosed the fact that every organic cell consists of Carbon compounds and mineral matter. This being qualitatively and quantitatively a characteristic feature of every separate part of the organism indicates decidedly that the mineral matter is not an accidental admixture, but on the contrary, it is one of the essential constituents and factors in the building up of every cell and tissue. The biological importance of the mineral matter becomes still more apparent when we consider its intimate connection with, and vital importance for such processes as osmotic pressure, electrolytic dissociation, conductivity, catalysis, absorption, precipitation, etc. Still, to be exact we must state that the mineral matter of organisms does vary in certain narrow limits, quantitatively as well as qualitatively. This variation depends upon the age of the organisms, their temporary specific states and functions, and the general environment comprising food, temperature, surroundings, hereditary tendencies and influences.

According to Spencer, L'Errera and Barattae-Botazzi, the elements found in organisms under ordinary conditions belong mostly to those of a low atomic weight. A, Ca, F, I, Mn, P, As(?), Cl, Fe, K, N, S, Br(?), Ce(?), H, Li, Na, Si, C, Cu, He(?), Mg, O, Zn.

The latest researches have shown the presence of Radium in some Carcinomatous Tumours, and the possibility of introducing by substitution of Barium, Strontium, Rubidium, Caesium, etc. Some of these elements, like K, Na, Ca, Cl, P, S, H, N, O, are quite universal in their distribution, whilst some like B, Cu, I, As, etc., are more or less located in definite parts of the organism and are met with only in very limited quantities.

Element Gases.

Oxygen : (Ref. Gorup-Besanez) is found to be present in all air-containing spaces in the animal body, and also is absorbed and combined in the blood and the tissues of the lungs.

Nitrogen : as a constituent of air is found in all air-containing spaces, in the blood, stomach ,intestines, etc.

Hydrogen : together with CH_4, etc., appears to be a product of decomposition in the process of digestion and the small quantities of hydrogen found in the blood or exhaled during respiration, seem to belong to the same source. (Regnault and Reiset).

Argon : as a constituent of air is naturally found wherever the latter is present. In the swimming bladder of fishes and in marine animals the same percentage of Argon is found as in the atmosphere. The solubility or Argon in blood is identical with that in water, and shows the presence of .419cm. per litre. (Th. Schlosing-Sohn and T. Richard, Regnard).

Helium : its presence can be attributed to two sources : (1) Introduced as a constituent of air, and (2) Produced on the disintegration of the emanation of Radium.

The Halogen Group.

Chlorine : is present in most cases, if not exclusively in the inorganic form as Cl-ions, as a chloride in the blood-lymph, and other animal juices, and as free HCl in the stomach-juices of the higher animals. The micro-chemical analysis indicates the intercellular substance to be exceptionally rich in Cl (A. B. Macallum).

The experiments of Nenski and Schumow-Seinanowski showed that the percentage of Cl in a dog varied between .01 per cent., and .268 per cent. the smallest being in the bile, the largest in the blood.

Bromine : The work of Rabuteau and Pappilon, Baldig, C. Paderi, E. Pribram and Bonninger proved the presence of Br in at least certain parts of some animals, to the extent of .01 per cent—.05 per cent.

of the total dry substance. Though the state of combination of Br has not been elucidated quite definitely, the very fact that it is possible to substitute wholly or partially the Cl of the organism by Br, by means of giving the animal NaBr instead of NaCl, indicates that the state of combination of Br is more or less similar to that of Cl.

Fluorine : Marichini as early as 1803, and Gay-Lussac in 1805, discovered Fluorine in ivory and teeth respectively. The great difficulty in the exact quantitative determination resulted in a variety of non-corresponding data obtained by Berzelius, Carnot, Zalesky, Wilson, Gabriel, H. Harms, Wrompelmeyer, and Todlbauer. The best recent determination is that of Todbauer (*Zeit. f. Biol.*, 41, 44) who made use of Hempel's method. His results, which are very near to those of Gabriel, show for teeth and bones the percentage of Fluorine to be .03—.36. In smaller quantities fluorine was also found in milk, blood, egg-albumen, etc. (G. Wilson, Nicles, Horsford, G. Tamman, etc.) Fluorine is found in the inorganic state of combination. Gautier and Clausmann found Fluorine to be specially concentrated in hair, down, fish-scales, nail, tortoise-shell, epidermis, bones, and teeth enamel. (1912-1913.) Gautier (1914), studying the relationship between Phosphorus and Fluorine, found it to be specific for each organ.

Iodine : Considering the fact that (a) marine animals are richer by far in iodine than the terrestrial ones (in sponges and seaweed as much as 8—14 per cent.; (b) the percentage content of Iodine is greater in herbivorous animals than in carnivorous; and (c) this percentage varies for the same kind of animal with the locality—being the greater the nearer to the sea—indicates that the iodine in animals is due to the marine vegetation, the iodine of which, in its turn is due to the special environment (Courtois, Fürth, Hundshagen). According to numerous investigations the iodine is organically combined, thus in sponges it is in the form of an albuminoid-iodospongin — $C_{56}H_{87}IN_{10}S_2O_2$ (Harnack, *Z. phys. chem.*, XXIV). Dreschel succeeded in isolating from corals an iodine-containing substance, called by him iodo-gorgonic acid (from Gorgonic Cavollinii, which is regarded by Wheeler and Jamison as similar to 3.5 Di-iodtyrisin, whilst Henze declares it to be identical with inactive Di-iodtyrisin.

Percentage of Iodine in Corals (dry substance).

	%	
Gorgonia flabellum ...	1.15	Mendel
Gorgonia acerosa ...	1.70	Mendel
Gorgonia Cavollinii ...	7.80	Dreschel
Plexaura flexuosa ...	0.28	Mendel

Baumann and Roas suggest that in higher animals and man the iodine is present in the form of iodothyrin, whilst Oswald (*Z. phys. chem.* XXXII.) supposes the iodine to be combined as a Globulin (Thyreoglobulin) ,this being specially concentrated in the Glandula Parathyreoddea (Gley, Mendel). Though the iodine is present in higher animals in quantities not exceeding those of Br and F, this does not minimise the possibility of its great physiological importance. Tittoff, Ascoli, Tzar, and others, have experimentally shown that very minute quantities of certain substances are capable of having considerable catalytic or similar effect. So minute quantities of Cu-ions as 10^{-10} gr. in a cub. cm. (.006 grm. of Cu per litre) are still noticeable in their effect in the oxidation of sodium sulphide; the same can be said about such quantities as 3/100 mgr. of MnO_2 and of colloidal arsenic tri-sulphide in their effect on the autolysis of the liver-tissues.

Sulphur : as an important constituent of the organism, occurs chiefly in the organic form, combined with the albumins. The sulphur-content o hair appears to be the largest, being, in the case of horse's hair, as much as 4—4.68 per cent. (Franz Düring). In other tissues, the percentage of sulphur is as follows :—

	%	
	Hugo Schulz.	
Man's muscles	1.1028	S. of dry substance
,, Liver ...	0.9643	,, ,, ,,
,, Heart ...	0.7916	,, ,, ,,
,, Spleen (milt)	0.7797	,, ,, ,,
,, Aorta ...	0.6264	,, ,, ,,
	Fried. Krüger.	
Calf's Liver ...	1.70-1.86	,, ,, ,,
,, Spleen (milt)	1.72-2.23	,, ,, ,,

Schulz found that the tissues of fish contain the largest percentage of sulphur, whilst the omni-vorous animals are richer in sulphur than the herbivorous.

Besides entering as a constituent in the molecule of the proteins, sulphur is also found in " organic " combination.

(1) In the acids of the bile and their products of decomposition (Taurin, etc.),

(2) In such intermediate substances as zystin, zystein, etc.

Sulphur occurs also as H_2S, sulphides, mercaptones, sulphates, rhodanides and free H_2SO_4.

Phosphorus : (1) In its inorganic form it occurs as phosphates chiefly, or calcium and magnesium, potassium and sodium.

(2) In its organic form—in all nucleo-proteids and lecithins, in jecorin, cerebrin, protagon, carno-phosphoric acid (Phosphorfleischsaüre) and many other organic combinations. The high percentage of phosphorus in its organic form in the nuclei of cells, in nerves, etc., clearly indicates its great physiological importance.

The following table gives the percentage of phosphorus in some tissues : —

	Hammerstein.	
	%	
Muscles ...	0.7 -1.0	of P (of dry sub.)
Brain ...	0.2 -0.4	,, ,, ,,
Spleen (milt)	1.26-2.43	,, ,, ,,
	Fried. Krüger.	
Liver (man)	1.28	,, ,, ,,
Liver (calf)	1.2 -1.74	,, ,, ,,

Arsenic : Gautier and Bertrand were the first to declare arsenic a normal constituent of the animal organism to the amount of 0.00007 (in milk)—0.067 (in dog's thyroid gland) mgr. of arsenic per 100 gr. of dry substance. This question as it stands at present must be regarded as an unsettled one. Whilst Guillaume and T. Garrigan, Zienike, and others proved by various methods that the arsenic is a normal constituent of the animal organism, Hödlmoser and Kunkel assert that carefully eliminating all possibilities of contamination and introduction of adventitious arsenic, no such element is found in a normal organism. But when we consider the important therapeutic effect of arsenic even in minute quantities, the fact that arsenic is a constituent of vegetables, and forms organic compounds with lecithins and nucleic acids, one is rather inclined to agree with the former conception.

Silicon : is widely distributed all through the animal kingdom, and is the important constituent of the skeletons of lower animals ,shells, hairs, feathers, epiderma, etc. In higher animals the percentage of SiO_2 varies between 0.705 (white of an egg) and 0.004 (calf's meat). F. Riegel, in his paper on Chalicosis pulmonum, puts the percentage of SiO_2 for the dry mass of the lungs as high as 3.37, and for the bronchial glands as much as 5.56. Analysing the ashes we, of course, obtain all the silicon, in the lower animals we find silicic acid. Whether all the silicon occurring in the organism is limited to these two inorganic modifications is more than doubtful. The recent works of Ladenburg and Dreschel have proved the existence of such organic compounds as $Si(OC_{31}H_{59}O)$ (Cholesterin $C_{31}H_{60}O_2$) which can be regarded as an ester of orthosilicic acid ,and Cholesterin, thus suggesting the possibility, if not the probability of at least a part of the silicon to be in the organic form.

(*To be Continued.*)

THE CHEMICAL SERVICE OF THE GOVERNMENT OF THE UNION OF SOUTH AFRICA : ITS ORGANISATION AND WORK.

By St. C. O. Sinclair, M.A., D.Sc., F.I.C.
Chief of the Division of Chemistry, Department of Agriculture, Union of South Africa.

(Abstracted from the Presidential Address to Section B, delivered July 6, 1926.)

Introduction.

A study of the many Addresses delivered in the past before this Association reveals that, on many occasions, the chemical problems before us in this land have been clearly pointed out, and that much useful advice has been afforded us as to the lines on which we should proceed.

The progress that has been made in the application of chemical science to the elucidation of the many questions affecting our welfare as a country has also from time to time been traced, and much interesting and useful information laid before us as to past conditions.

Throughout these Addresses there seems, however, to travel a note of regret that, while the problems confronting us are both numerous and pressing, progress has not been over speedy and circumstances have much militated against that full development of the science of chemistry, which is so essential for the advancement of a young nation such as ours.

I have, therefore, felt that it would not be inappropriate to the occasion if I were to take advantage of the opportunity you have given me in electing me to be your president of Section B to lay before you some of the problems on which the Government Chemical Officers are engaged, to indicate the lines on which they are proceeding and to explain the organisation which

exists for the conduct of the chemical work of the Union Government.

One of the objects of this Association is to assist in giving " a stronger impulse and a more systematic direction to scientific enquiry and research." It is hoped that a statement indicative of the activities of the Government Chemical Service will be helpful in the furtherance of that object.

ORGANISATION OF THE GOVERNMENT CHEMICAL SERVICE.

The Government chemical work of the country is distributed between four groups of officers :—

(1) The staff of the Division of Chemistry.
(2) The chemical staffs of the Schools of Agriculture.
(3) The chemical staff of the Veterinary Research Institute at Onderstepoort.
(4) The industrial chemist.

Groups 1, 2 and 3 belong to the State Department of Agriculture. Group 4 consists of one chemist, who is an officer of the Board of Trade and Industries and thus of the State Department of Mines and Industries, to which department the Board of Trade and Industries is attached.

The Division of Chemistry comprises three series of laboratories—one at Capetown, one at Johannesburg, and one at Pretoria, each series being under the personal command of an officer of senior rank —while the whole is controlled by a Chief of Division stationed at Pretoria.

Prior to 1st May, 1923, the laboratories constituting the present Division of Chemistry, existed as separate institutions split up between the State Departments of Public Health and Agriculture, the laboratories of the latter Department being concerned almost exclusively with investigational work of an agricultural nature, while the Public Health Laboratories were charged with the conduct of the chemical work—both investigational and regulatory—required to be performed for their purposes by all Government departments of State.

On the date quoted, effect was given to the long-standing proposal that all Government chemical work should be consolidated in one Division by incorporating the laboratories under the control of the Public Health Department with those of the Division of Chemistry of the Department of Agriculture. Since the Division of Chemistry is, consequently, now called upon to undertake the chemical work of Department of State so diverse in their functions as for instance the Department of Justice and the Department of Finance, the Department of Finance, the Department of Mines and the Department of Agriculture, the Department of Public Health and the Department of Posts and Telegraphs, it follows that its activities, both in regard to its investigational as well as regulatory work, extend over a wide field.

The chemical officers of the Schools of Agriculture are officers of the Division of Extension and Agricultural Education of the Department of Agriculture. They are engaged entirely on agricultural chemical work and act in a threefold capacity, namely, as research officers, as lecturers in chemistry and as extension officers. As research officers, they conduct enquiries into problems connected with soil conditions, fertilisers, animal nutrition, fruit and the like. As lecturers, they give instruction in the applications of chemical science to students resident at the Schools as well as short courses to agriculturists and others. Their duties as extension officers require them to travel to various centres to lecture at farmers' meetings and the like and also to staff the chemical coach of the agricultural demonstration train. Much of their time is also taken up in giving advice on agricultural matters by way of correspondence and through the medium of the Press. Chemical analyses of samples of soil, fertilisers, water and other materials sent in my farmers are also undertaken by the School chemists. Whilst these officers are not members of the staff of the Division of Chemistry, their research and investigational work is subject to co-ordination and correlation by the Chief of the Division of Chemistry, to whom they report in this connection from time to time.

The chemical staff of the laboratories of the Division of Veterinary Education and Research at Onderstepoort is under the personal control of a sub-director of that Division, and thus entirely separate from those of the Division of Chemistry and the Agricultural Schools.

This staff carries out specialised chemical work in the domain of biochemistry and is, at present, much engaged on research in regard to animal nutrition, including mineral deficiencies in stock rations and general biochemical problems connected with the livestock industry—some of the results ofwhich will be laid before this meeting. Experiments with poisonous plants also find a place here, whilst soil problems in relation to animal nutrition are also being investigated. A certain measure of routine work in connection with stock

dips, stock remedies and stock poisoning is also performed.

As there is close co-operation between the chemical staff at Onderstepoort and that of the Division of Chemistry, no overlapping of work takes place.

The industrial chemist of the Board of Trades and Industries, who constitutes Group 4, is the latest addition to the family of Government Chemical Officers. His functions are to carry out such investigations in connection with industrial questions as the Board may require from time to time. For disciplinary purposes he is under the control of the Chief of the Division of Chemistry.

WORK OF THE GOVERNMENT CHEMISTS.

It is fully apparent from what I have just stated with regard to its organisation that the work of the Government chemists is both research and investigational as well as regulatory and routine in nature.

When it is remembered that agriculture is our fundamental industry, it will be easily understood why very nearly the whole of the research activities of the Government chemists consists of enquiries into problems which have a direct agricultural bearing.

Furthermore, since it can be enunciated that our future as a country depends upon the establishment of a permanent system of agriculture, and that the foundations of such a system rest on the soil and its productivity, it is no matter of surprise that investigations concerning the relationships between the soil and the crops produced on them play almost the predominant part in the work of our chemists.

The basic principles underlying the relationship between soil and crop production apply in any part of the world, but the application of these principles in any particular country requires to be specially studied with reference to the conditions peculiar to such country.

For this reason, therefore, we have to view problems under investigation in other lands from different angles, and, whilst making every use of the experience of other workers, attack these problems anew in a somewhat different manner.

Our first efforts then must be to gain as much knowledge of our soils and soil conditions as is possible.

To this end a systematic soil survey of the Union has been instituted, and the work, organised and directed from the Pretoria Laboratory, is now proceeding in separate localities on the several aspects of soil investigation.

BRAK INVESTIGATIONS.

From this general consideration of the work undertaken in connection with our soils, I pass now to that particular phase of it which, at the moment, constitutes one of the most important matters which the Government Chemical Officers are being required to deal with—namely, the investigation of brak in our irrigated and irrigable lands.

In days gone by, irrigation was regarded as almost entirely the concern of the engineer. Now, however, one of the first steps taken in connection with an irrigation scheme is to enquire whether the soil conditions of the land to be put under irrigation are such that the irrigation scheme is likely to prove a successful venture, and, as the Secretary for Agriculture remarks in his annual report for 1925, " no important irrigation scheme is now under consideration without a soil survey of the area which will be brought under irrigation."

FERTILISER EXPERIMENTS

Investigations into the several steps to be adopted for the maintenance of the fertility of our soils have, as is only to be expected, a large share in the activities of the Government chemical officers.

In connection with these, questions attending the use of fertilisers come naturally into prominence and, consequently, many experiments are now being conducted in elucidation of the several problems which arise in farming practice.

Owing to variety in the type of soil and in the conditions, climatic and other, the demands of a particular crop upon the soil are not uniformly alike in each area in which it is grown.

Now, although soil investigation is a valuable aid in drawing up schemes of fertilised trials, the plant is the arbiter as to which of our proposed treatments best meets its needs.

Our fertiliser experiments, therefore, are carried out with a variety of combinations of fertilisers on soils of different types and with various crops. The varying effects of climate also render it necessary to continue experiments over a number of seasons before results sufficiently reliable to admit of generalisation are obtained.

FRUIT INVESTIGATIONS.

Of the several branches of investigation undertaken by the chemical staffs of the Division of Chemistry and the Schools of

Agriculture, those relating to the composition of fruits of various kinds are not amongst the least important.

Citrus culture is one of our most important fruit industries. One estimate is that in the next five years, the citrus export trade, if the present rate of expansion is maintained, is likely to reach the big total of 7,000,000 boxes per annum. Much attention is, therefore, now being devoted to it and, consequently, among the foremost investigations carried out by the staffs of Division of Chemistry and the chemistry section of the Schools are those in connection with the composition of South African citrus fruits.

For the control of the false codling moth in citrus trees, it is the universal practice to treat the trees with sprays containing lead arsenate, and it has, therefore, been thought advisable to ascertain to what, if any, extent such treatment of the trees influences their fruit. With this object in view, the Division of Chemistry in conjunction with the Division of Entomology have now carried on investigations for some time.

The Public Health (Preservative, etc., in Food) Regulations made by the Minister of Health, England, in August last prohibit as from 1st January next, the importation into England or Wales of any dried fruit containing the preservative sulphur dioxide in a greater amount than 2,000 parts per million in the case of dried apricots, nectarines, peaches, apples and pears, and 750 parts per million in the case of raisins and sultanas. In view of the fact that in the preparation of these commodities it is necessary to subject them to the fumes of burning sulphur, the question of the application of the regulations becomes a matter of importance to the dried fruit industry. Investigations are, therefore, in progress to ascertain the extent to which dried fruit as prepared in the Union complies with the regulations, and, if necessary, to devise processes by which the amount of sulphur dioxide in the fruit product may be duly controlled.

PRICKLY PEAR AND JOINTED CACTUS.

Several species of Opuntia, popularly known as prickly pear and jointed cactus have now so spread in many parts of the Union as to have become a pest, and the questions as to how this pest can be successfully held in check and the land already affected reclaimed for pastoral and agricultural purposes have become of urgent concern. The problem can be attacked in four ways :—

(1) Poisoning the plants; (2) employment of natural enemies; (3) utilisation of the plant for fodder and other purposes; (4) mechanical eradication — uprooting and burning.

In consequence of the recognised need for systematic investigation in the matter, the Division of Chemistry has taken up the enquiry into methods best adopted for destruction of the plants by poison.

The poison has now to be tested under South African conditions of climate and variety of pear, not only to ascertain whether its use is equally as satisfactory as far as destroying the plant is concerned, but also whether its use is feasible on economic grounds. It is to be remembered that, whilst a poison might be very efficient and certain in its action, the cost of its application might be so great as to render its use not economically possible—the value of the land cleared might be less than the cost of clearing it.

The preliminary experiments made by the Division of Chemistry with arsenic pentoxide have been encouraging in results, and arrangements are now being made for further large scale experiments are now being made for further large scale experiments with suitable apparatus imported from Australia to ascertain in how far the Australian experience with arsenic pentoxide is likely to be ours. For the purpose of these experiments, the Municipal Council of Uitenhage has kindly co-operated by placing an area of 20 acres of land properly fenced at our disposal. Should it be found that arsenic pentoxide is too costly for general use in South Africa the Division will continue its investigations with a view to ascertaining the feasibility of using arsenites and certain other substances which have already been tried with more or less success.

It has already been stated that one of the requirements of an ideal destroyer is certainty of results. The poison must lead to complete destruction of the plant. It has been found that many substances when injected into the plant succeed merely in causing local death of the inoculated portion of the plant, and that, even when the poison penetrates to a considerable extent, it does not travel sufficiently to reach the roots, the plant being thus left to sprout again.

In concluding my remarks with regard to the investigational work of the Government chemists, I would like to say that, though of necessity the bulk of their work lies in

the direction of agricultural investigation, a certain amount of enquiry is also directed to matters apart therefrom. Thus the toxicological chemists at the Johannesburg Laboratory have from time to time investigated the constituents of plants used by native poisoners. In connection with poisonous plants certain work carried out at the Onderstepoort Veterinary Research Institute is to come before us at this meeting.

REGULATORY WORK.

As will have been concluded from what I have already explained with regard to the organisation of the Government Chemical Services, the regulatory work performed by the chemical officers of the Government is of a very varied nature.

CONCLUSION.

In this address I have endeavoured to give an account of the organisation of the chemical service of the Government and the manner in which it functions.

I trust that in so doing, I have given some information to assist our Association in gauging how far we have profited by the experience of the past, are adequate to the needs of the present and are prepared for the contingencies of the future.

The present is the age of specialisation—I would like to state it as a necessary corollary that it must therefore also be the age of co-operation.

Chemistry—organic, inorganic and physical—is a basal science, and is the handmaiden of all other sciences. Just as it requirse to be so recognised, so also is it fully conscious of the fact that, in order to find its fullest expression, it needs the co-operation of, amongst others, the sciences of geology, metallurgy, mineralogy, and geography, which are grouped with chemistry under Section B.

I trust that during the course of my remarks I have, at least, given some indication that this is so.

General Notes.

ESTONIAN BUTTER EXPORTS.

The British Consul-General at Reval reports that during the first three months of the current year exports of butter from Estonia amounted to 1,216.5 tons, of which 1,061.1 tons went to Germany, 147.9 tons to the United Kingdom, 6.3 tons to Denmark, and 2.2 tons to Finland.

BRITISH STANDARD SPECIFICATIONS.

The British Engineering Standards Associations has recently issued new British Standard Specifications for Instrument Transformers (No. 81-1927) and Graphic (Recording or Chart-Recording) Ammeters, Voltmeters and Wattmeters (No. 90-1927). These two specifications are revisions of the 1919 editions, and have been brought into line with other British standard specifications for electrical instruments, there now being a series of four up-to-date specifications, as follows:—Indicating, Instruments, No. 89; Graphic (Recording) Instruments, No. 90; Electrical Protective Relays, No. 142; and Instrument Transformers, No. 81.

B.S.S. No. 81, Instrument Transformers, deals with the testing of current and voltage-transformers, the rated secondary current or voltage, ratios of transformation, limits of temperature rise and the rated burdens. B.S.S. No. 90, Graphic (Recording or Chart-Recording) Ammeters, Voltmeters and Wattmeters, is, in effect, a sister specification to British Standard Specification No. 89-1926, special attention being devoted to the clock or driving mechanism and to the effect of the pen-to paper friction. Chart speeds and chart rulings are also dealt with, as are also the limits of error and the methods of testing for accuracy.

Copies of these revised specifications may be obtained from the British Engineering Standards Association (Publications Department), 28, Victoria Street, London, S.W.1., or from the publishers, Crosby Lockwood and Son, 7, Stationers' Hall Court, London, E.C.4., price 2s. 2d. each, post free.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

APPLICATIONS FOR LICENCES IN APRIL, 1927.

The following statement relating to applications for licenses under the Dyestuffs (Import Regulation) Act, 1920, made during April, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 624, of which 496 were from merchants or importers. To these should be added 26 cases outstanding on the 31st March, making a total for the month of 650.

IN THE INTEREST OF THE COMMUNITY.

Lady Hunter of 14, Eaton Square, London, S.W.1., critises the erratic recording powers of gas-meters, and makes the capital suggestion that the various gas companies should render their accounts monthly, so that the housewives will see how they stand, rather than receive a stunning shock by the size of the quarter's gas bill.

ROYAL INSTITUTION.

A general meeting of the members of the Royal Institution was held on Monday afternoon, May 9, Sir Arthur Keith, Treasurer and Vice-President, in the chair. Sir J. J. Thomson was elected Honorary Professor of Natural Philosophy, and Sir Ernest Rutherford, Professor of Natural Philosophy. The chairman announced that the President, His Grace the Duke of Northumberland, had nominated Sir James-Crichton-Browne, Dr. J. Mitchell Bruce, Sir Dugald Clerk, Sir Ernest Moon, Hon. Sir Charles Parsons, Sir Almroth Wright, Sir Arthur Keith and Sir Robert Robertson as Vice-Presidents for the ensuing year. Mrs. M. S. Atkinson Adam, Mr. D. K. C. Birt, Sir Arthur Duckham, Mr. P. V. Hunter, Dr. Samuel Insull, Mr. Archibald McKinistry, Mr. Charles P. Sparks, and Sir Alexander Walker were elected Members.

TRACTOR SALES IN CANADA.

During 1926 the number of tractors sold in Manitoba, Saskatchewan and Alberta was 6,513, as compared with 4,053 in 1925. Of this total Saskatchewan took 3,704, as against 2,176 in 1925, Manitoba 1,498 (1,008), and Alberta 1,311 (896).

BELGIAN SUGAR OUTPUT.

The British Commercial Secretary at Brussels has forwarded the following details of Belgian sugar output, stocks and consumption during March, as published in the *Moniteur Belge* :—

Output of factories, 256,800 kilogs; production of refineries, 12,577,263 kilogs; stocks at the end of the month, 95,71,338 kilogs; month's consumption, 10,950,508 kilogs.

INDUSTRIAL DESIGNS COMPETITION.

The Secretary of the Royal Society of Arts reports that by kind permission of the Board of Governers of the Imperial Institute, this year's Competition of Industrial Designs will be held in the Indian Pavilion of the Imperial Institute, South Kensington, London, S.W.7.

Full particulars of the Scholarships and prizes offered in connection with the Competition can be obtained from the Secretary of the Royal Society of Arts, John Street, Adelphi, London, W.C.2., to whom applications for forms of entry, labels, and instructions must be sent between 2, and 15, May.

The designs entered for the Competition are to be forwarded to the Imperial Institute between 20 and 22, June, and after the judging, which takes place in July, the accepted designs will be on view there during the whole of August (Sundays included).

GREAT POSSIBILITIES OF THE STICKINE RIVER AREA, B.C.

It has long been known that a fairly broad area along the eastern contact of the Coast Range Batholith in British Columbia is geologically favourable for the occurrence of mineral deposits. This has been amply borne out by the discovery of many valuable ore deposits in areas adjacent to Portland Canal, Alice Arm, Atlin Lake, and at other points farther north and south. One of the serious obstacles to the development of the mineral resources east of the Coast range has been a decided lack of economical transportation.

TALC AND SOAPSTONE INDUSTRY.

The Dominion Bureau of Statistics reports that the improvement shown in the talc and soapstone industry in Canada during 1925 was continued throughout 1926. Shipments in the year under review totalled 15,767 tons valued at $217,195 as compared with 14,471 tons at $205,835 shipped in 1925.

ASBESTOS.

Asbestos production in Canada during 1926 reached the grand total of 279,389 tons with a valuation of $10,095,487; an average value of $36.13 per ton. In 1925 the shipments (exclusive of sand and gravel) amounted to 273,524 tons at $8,977,546, or an average value of $32.82 per ton.

Asbestos rock mined during 1926 totalled 4,483,361 tons, of which quantity 4,002,626 tons were handled by the mills.

FIRST YEAST INDUSTRY IN WESTERN CANADA.

A new industry, the first of its kind in Western Canada, has been recently brought into operation at Edmonton, Alberta. The NorthWest Brewing Company has installed yeast-making machinery capable of a daily production of a ton to a ton and a half of bakers' yeast, not the brewers' variety. The plant, which cost $35,000 to instal, will utilise locally-produced rye and other raw products and the alcohol which is run off as a by-product will likely be denatured and sold for industrial purposes. At present fresh yeast is being imported into Western Canada from the western United States, and the new Canadian product will have an advantage in time of delivery to bakers in Alberta and other western provinces.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The ninety-seventh annual meeting will be held at Leeds from Wednesday, August 31, to September 7 inclusive. The Reception Room will be at the Leeds Town Hall, which opens on August 30. Lists of the Sectional Officers of the various Sections A to M are already published. The City and University of Leeds are arranging to give a real Yorkshire welcome to the Association. Leeds was twice previously visited, in 1858 and 1890. Since both these dates, wonderful changes have taken place not only to Leeds, but to chemistry and all branches of science and art. Each year the scientific and general educated public looks forward to the announcements of progress made in science and art which are announced at the Association's meeting.

The Inaugural Meeting will be held on Wednesday, August 31, when the President (Sir Arthur Keith, M.D., LL.D., F.R.S.), will deliver an address on "Darwin's Theory of Man's Descent as it Stands To-day." The address will be given in the Majestic Cinema, City Square. On the evenings of September 2 and 5, evening addresses will be delivered in the Albert Hall, the first by Prof. R. A. Millikan, on "Cosmic Rays," and the second by Dr. F. A. F. Crew, on "*The Germplasm and its* Architecture." Elaborate arrangements for receptions, excursions, etc., are being made.

PROGRESSIVE LIVERPOOL.

From the Liverpool Organisation for advancing the interests of Liverpool, of 3, Lord Street, Liverpool comes a well got-up and handsomely illustrated and printed book which is full of facts and information illustrating the importance of Liverpool and notably the great advantages which it offers to those seeking sites for factories. Among the advantages are cheap coal and motive power, low rates, female labour and clean and healthy surroundings.

PROCEEDINGS AND NOTICES OF SOCIETIES.

SOCIETY OF PUBLIC ANALYSTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday May 4, Mr. E. Richards Bolton, President, being in the chair.

Certificates were read for the first time in favour of Messrs. Charles Edwin Corfield, B.Sc., F.I.C., Harold E. C. Powers, B.Sc., A.I.C., John Rogers, and Abraham Samson, A.R.C.Sc., A.I.C.

Certificates were read for the second time in favour of Messrs. Frederick Cecil Bullock, B.Sc., A.I.C., Thomas Harold Fairbrother, M.Sc., F.I.C., Ralph Skinner Rack, and Samuel George Sherman.

The following were elected members of the Society: Alfred George James Lipscombe, M.Sc., A.I.C., William L. Matthews, Sydney John Rogers, B.Sc., F.I.C., Ernest Fred Waterhouse, Harold William Webb, Arthur Samuel Wood, M.Sc., Ph.D., F.I.C.

The following papers were read and discussed :—

Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates. VII. The Precipitation of Tungstic Acid by Tannin. VIII. The Separation of Tungsten from Tantalum and Niobium. By W. R. Schoeller, Ph.D., and C. Jahn.

Small quantities of tungstic acid are quantitatively recovered from tungsten solutions containing alkali chloride by precipitation with tannin and cinchonine hydrochloride. A method of determining small amounts of tungsten in the presence of large amounts of earth acids has been based on this principle. Small amounts of earth acids in tungstic trioxide are determined by fusing the mixture with sodium hydroxide and treating the fused mass with sodium chloride solution; sodium tantalate and niobate remain undissolved.

The Separation of Vanadium and Tungsten. By S. G. Clarke, B.Sc., A.I.C.

Vanadium may be determined in the presence of large amounts of tungsten by precipitation with cupferron (ammonium salt of nitroso-phenyl hydroxylamine) after treatment of the solution with hydrofluoric acid, neutralisation with ammonia, addition of hydrochloric acid and dilution. The precipitate is separated, washed and ignited at a low temperature, the residual vanadium pentoxide dissolved in dilute sulphuric acid, and the solution reduced with sulphur dioxide and titrated with permanganate.

The Determination of Moisture by the Volatile Solvent Method. By J. M. Jones and T. McLachlan, A.I.C.

This method of determining moisture is satisfactory for emulsions, such as butter and margarine, and gives more consistent results than any other method for such products as jam, honey and malt extract, though it is not possible to say whether these results are accurate For powders which do not cake the water-oven and air-oven method is preferable to this method. The use of toluene as a solvent enables the results to be obtained in a shorter time than when benzene or petroleum spirit is used.

A Study of Antimony Trichloride as a Possible Quantitative Reagent for Vitamine A. By F. Wokes ,B.Sc., F.I.C., and S. G. Willimott, Ph.D., B.Sc., A.I.C.

The reaction between antimony trichloride and vitamin A is probably due to condensation, and can be retarded by dehydration of the solvent. The depth of the initial blue coloration obtained under standard conditions may be used to measure the vitamin A content of the oil. The intensity of colour is expressed in Lovibond blue units 30 seconds after mixing the solution of the oil and reagent.

New Processes for the Determination of Certain Elements in Lead. By B. S. Evans, Ph.D., F.I.C.

The sample is dissolved in nitric acid, lead separated as sulphate, and arsenic precipitated with sodium hypophosphite and separated by shaking with benzene and filtering. Antimony is determined in the filtrate, and the arsenic in the precipitate is determined by an iodimetric method. Bismuth is determined colorimetrically with potassium iodide after separation of the lead as sulphate and chloride, and sulphur is determined gravimetrically after dissolving the metal in *aque regia*, evaporating the solution to dryness, and dissolving the residue in dilute hydrochloric acid.

SOCIETY OF GLASS TECHNOLOGY.

The tenth Annual General Meeting of the Society of Glass Technology was held in Sheffield on Wednesday, April 27, 1927, the President, Mr. Walter Butterworth, Senior, M.A., in the chair.

Mr. W. Butterworth was re-elected President, and the following officers were elected to fill vacancies arising in accordance with the Society's " Constitution and Rules."

Vice-Presidents— H. A. Bateson and W. J. Rees, B.Sc.Tech., F.I.C.

Ordinary Members of Council—J. D. Cauwood, M.Sc., A.I.C.; F. Graves Clark; Miss V. Dimbleby, M.Sc.; G. V. Evers; and W. W. Warren, A.M.I.C.E., A.M.I.E.E.

Honorary Treasurers—(General) J. Connolly; (American) F. C. Flint, B.S.

Honorary Secretary—Prof. W. E. S. Turner, D.Sc.

Auditors — C. S. Davey; D. Wood, F.S.A.A.

At the Ordinary General Meeting which followed a discussion on Furnace Efficiency was inaugurated by Prof. W. E. S. Turner, in a paper entitled "A Brief Review of Furnace Developments."

Professor Turner stated that his intention was to survey the present position of furnace practice in this country and abroad as the basis for considering possible lines of advancement in the future.

Dealing with the operation of pot furnaces in this country data were given of numerous furnaces engaged upon various types of work, some of the observations dating back to 1916. It was evident from the figures that (a) a saving in fuel was obtained by the newer types of recuperative or regenerative furnaces; (b) heavy expense was incurred by the practice of founding only once a week; (c) the fuel consumption was greatly increased when the eye of the furnace had worn big. The efficiency of modern British pot furnaces compared favourably with those of Germany.

Among the improvements effected during the last few years in furnace design were (1) greater compactness; (2) better utilisation of waste heat; (3) the introduction of tangential burners; and (4) sillimanite sieges. The type of ware made greatly affected the efficiency, while mutual consideration of the problem by masters and men of methods of working should result in greater output at less cost.

Passing to the consideration of tank furnaces Professor Turner gave data of numerout tanks working for hand operation, for semi-automatic bottle machines, for mixed automatics and semi-automatic machines, and for fully automatic machines. Very few data were available relative to Continental practice, but from figures quoted by H. Maurach in 1925 the results obtained in Germany were probably not as good as those reached in this country. Speaking generally, tank furnace practice on the Continent had not reached the British attainment, which was now equal to anything yet achieved in America.

The main sources of economy with a view to increasing efficiency were indicated. Among the problems which still required more thorough examination were :—

(a) Design of ports. End ports in some cases appeared to give longer life to tank blocks;
(b) Bridges, the form of the basin and whether there should be one or two dog-houses.
(c) Depth of the refining end of the tank, whether it should be less than at the melting end;
(d) Utilisation of waste heat, and
(e) Increased insulation in various parts of the furnace, crown, side walls, etc.

In conclusion, Professor Turner referred to a suggestion made by Mr. B. F. Dudding that it would be a good thing to see how far it was possible by a national exchange of information to develop furnace operation to a fuller stage. The Department of Glass Technology of Sheffield University had recognised the importance of the problem and several series of systematic measurements had already been carried out by members of the staff, at the request of some manufacturers. Work on these lines had been carried out in Germany since 1920, when an institution was set up to study the problems of furnaces and fuel in the glass industry. Similar systematic furnace measurements were needed in this country since the sound lines for real progress must rest on measured data.

THE INSTITUTE OF METALS.

May Lecture.

Growth of Crystals.

Sir Henry A. Miers, F.R.S., delivered the seventeenth annual May lecture before the Institute of Metals, at Storey's Gate, Westminster, S.W.1., on Wednesday, May 11.

He recalled in the address experiments made twenty years ago by himself and Miss Isaac which seemed at that time to show that when a solution is cooled below its saturation temperature it passes into a "metastable" state in which crystals can only be produced by introducing a fragment of the dissolved substance or of one isomorphous with it, and that at a lower temperature it passes into a "labile" state in which crystals may appear spontaneously. Later investigations have shown that in the metastable state crystallisation can also be produced by shock.

The author however considered that his experiments record the normal behaviour of crystallising liquids and that crystallisation only takes place with some degree of supersaturation or undercooling. In his experiments there was always a sudden outburst of crystal growth at a definite temperature.

Little importance is ascribed to undercooling by most geologists in their speculations concerning the crystallisation of molten magmas, but to many metallurgists it is a very important factor. The structure of alloys is in many cases attributed to a suspended crystallisation of this nature; not only as they solidify from the molten state, but also during the crystalline changes which take place in the solid alloy with change of temperature, for example in steel, and in magnetic alloys.

HELIUM IN CANADA.

From 1922 to 1926, the Mines Branch of the Dominion Department of Mines as part of a survey of the natural gas resources of Canada made a special study of the helium content of the gases, and a thorough examination was made of all possible sources of this element.

Ten years ago helium was considered a rare substance, occupying in regard to its rarity and value, the same position among the different gases known to the chemist, that radium holds among metals. It was discovered in 1895 by the late Sir William Ramsay and owing to its remarkable properties and its relation to the phenomenon of radioactivity, it aroused much interest among scientists.

Following the discovery by two American chemists that some natural gases contained helium in small amount, and the suggestion by a British scientist that it might be commercially possible to obtain helium from such natural gas in sufficient quantity to fill balloons and airships for war-time use, extensive investigations, commenced in 1917, were carried out in the United States, and on a smaller scale in Canada. As a result, up to the end of 1926, over twenty-five million cubic feet of helium has been produced by the United States Government, and costs of production reduced to a basis that will permit of commercial utilisation. Helium was also extracted in small amount in the experimental plant at Calgary, operated under the direction of Professor J. C. McLennan, F.R.S., of the University of Toronto in 1919-1920, for the British Admiralty.

Helium possesses many remarkable properties which may make it a very valuable industrial gas. It is an ideal gas for filling balloons and airships, for although it has ten per cent. less buoyancy than hydrogen, it has the great advantage of being non-inflammable. The ill-fated United States airship Shenandoah was filled with helium. But for this it is believed that there would have been much more serious loss of life when the disaster took place. Helium is also used in U.S. Airship Los Angeles.

An application of helium that promises to become of great value is its use in making up artificial atmospheres to supply to divers and caisson workers. An investigation, still in progress, by the United States Bureau of Mines, has shown that there are great possibilities along these lines, and that such artificial oxygen-helium " airs " may permit of greater depths being attained and longer periods being spent under water by divers, and the prevention of caisson disease among tunnel and caisson workers. Suggestions for other industrial uses have been put forward, but outside of the United States, no commercial supplies have yet been available, and there have been no opportunities for investigation and experiment.

In the survey of helium resources in Canada made by the Mines Branch it was found that the gas from three small wells at Inglewood, Ontario, contained as high a percentage of helium as that treated in the United States Government plant at Fort Worth, Texas. The Ontario Government has since taken up many of the leases in this neighbourhood, and it is anticipated that the National Research Council may establish an experimental helium extraction plant, if it be proved that sufficient gas is available. A few wells in other fields in Ontario, particularly in Norfolk County, yield gas carrying 0.5 per cent. helium. Natural gas in Alberta, where much larger quantities are available than in Ontario was found to contain little or no helium, with the exception of that from the Bow Island and Foremost fields. If natural gas, containing as little as 0.2 per cent. helium could be economically processed to extract helium, it is calculated that about five million cubic feet could be obtained in Canada annually. Canada is the only present known source of helium in the British Empire.

The results of this investigation are described in a report " Helium in Canada," by Dr. R. T. Elworthy, recently issued by the Mines Branch. It contains a brief account of the particulars and occurrences

of helium, the methods employed in the work, particulars of the gas fields, including analyses of many gases, and some account of the methods of recovery of helium and its uses. Copies may be obtained on application to the Director, Mines Branch, Department of Mines, Ottawa, Canada.

NOTICES OF BOOKS.

The Chemists' Year Book, 1927. Edited by F. W. Atack, M.Sc.Tech., D.Sc. (Man.), B.Sc. (Lond.), Fellow of the Institute of Chemistry. Pp. 1200. Price 21s. net. Manchester: Sherratt and Hughes, 34, Cross Street.

In addition to all the usual well-known features, this year's edition contains a section on trade names of drugs, pharmaceutical names of synthetic compounds. The various sections have been revised and where considered expedient, extended. It is obvious that the Editor received a good deal of sympathetic co-operation to enable him to produce a book with such a mass of varied information.

Oil and Retortable Materials. A Handbook on the Utilisation of Coal, Tarbanite, Cannel and Oil Shale. By George W. Hulse, B.Sc. (Lond. Hon.) Pp. 146. Price 7s. 6d. London: Charles Griffin and Company, Ltd., 42, Drury Lane, W.C.2.

Fuel, motive power, luminants, etc., fill a most important place in the community, and an authoritative work on these subjects is appropriate and welcome. The author deals with practically all aspects of the subject, taking one of the illustrations at random that on p. 3., there is shewn in graph form the wonderful increase in the production of both coal and petroleum during the past 30 years, which makes one wonder whether the time is so far distant when the supplies will become so depleted as to cause a great increase in the cost of production and hence of price to the consumer. The work is well printed and strongly and handsomely bound.

Spectroscopy. Vol II. Edited by E. C. C. Baly, C.B.E., M.Sc., F.R.S. With 95 illustrations and three plates Pp. VIII + 398. Price 18s. net. London: Longman, Green and Co., Ltd.

The remarkable advance made in spectroscopy in recent years has necessitated the issue of four volumes instead of the one first contemplated. The present volume deals largely with inferometer methods, methods of illumination, nature of spectra, fluorescence and phosphorescence and the photography of the spectrum. There is left ample material for the third and fourth volumes. While it would, of course, be well for one to possess the whole four volumes, each is complete in itself, so far the the subjects dealt with. The illustrations in the part are numerous (extending to 95) and facing pages 362 and 365 are three valuable plates. The work is divided into five chapters, each of which gives a fairly complete summary of the subjects treated in the body of the work, while at the end of the book there is a copious index.

Reports of the Progress of Applied Chemistry. Vol. 11. Pp. 752. Society of Chemical Industry, 47-47, Finsbury Square, London ,E.C.2. Price, to members, 7s. 6d., non-membeis, 12s. 6d.

For all connected with the chemical and allied industry, this is a valuable reference book, about 25 main subjects are adequately dealt with by experts. It certainly is a volume which ought to be in the library of every live chemist; and would be an important book for any intelligent member of the community who wishes to be kept *au courant* with the trend of chemical science and art. The price, too, is so moderate as to place it within the the reach of the multitude. We shall probably have occasion to refer to it again.

ANTI-SMOKE POLICY FOR LONDON.

Conference of Local Authorities.

(From a Correspondent.)

With the object of securing the most beneficial results from the New Smoke Abatement Act, the Coal Smoke Abatement Society has issued invitations to every local authority in the Greater London area to send delegates to a conference to be held in July.

Mr. Neville Chamberlain, Minister of Health, has agreed to attend, and the discussions will mainly centre round securing a uniform anti-smoke policy for the whole of London and district. The conference will receive carefully prepared statements on the legal effect of the powers conferred by the new Act and will be invited to explore the whole subject of Smoke Abatement. It

will also consider suggestions regarding uniform bye-laws, and endeavour to ascertain whether the London local authorities will avail themselves of the right to take joint action in enforcing the provisions of the Act.

In view of the wide scope of the conference it is probable that domestic smoke, which is held to be responsible for more than three-quarters of the smoke which causes London fogs, will be discussed in the light of the Ministry's recent reminder that powers are already possessed by local authorities for encouraging and extending the use of smokeless equipment. It is pointed out that the interests of the various cities, boroughs, and urban districts comprising Greater London, are closely connected in the matter of smoke abatement, inasmuch as industrial and domestic smoke created by one district is liable to drift across London to the discomfort of districts many miles away.

The conference may possibly result in the setting up of a permanent joint Smoke Abatement Committee for London.

FORTHCOMING EVENTS.

LONDON UNIVERSITY.

University College, Gower Street, W.C.1.

Monday May 23, at 5.30 p.m.—An Address : " Lord Lister and the Romance of Surgery," by Mr. Raymond Johnson, O.B.E., F.R.C.S., Fellow of the College. Chairman : The Dean of the Medical School, Dr. A. M. H. Gray. (For Members of the College and Medical School only.)

Wednesday, May 25, at 5.30 p.m.—Recital of Norwegian Poems (English Translations) by Miss Arna Heni.

Thursday, May 26, at 2.30 p.m.—"Recent Discoveries in Palestine : The City of Gerar." A public introductory Lecture by Professor Sir Flinders Petrie, F.R.S. (Lantern Illustrations.) This lecture will be repeated on Saturday ,May 28, at 3 p.m. and on Monday ,May 30, at 5.30 p.m.

ROYAL INSTITUTION.

21, Albemarle Street.

Friday, May 27, at 9 p.m.—His Excellency The Marquis De Merry Del Val, G.C.V.O., LL.D., Spanish Ambassador : " Gabriel y Galan, Contemporary Spanish Poet." (With quotations in Spanish.)

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

11,372.—Brightman, R.—Dyes. April 28th.

11,216.—Dean, C. L. — Drying dyers' Ltd.—Removal of free chlorine acid bromine from fluid mixtures. April 27th.

11,216.—Dean, C. L.—Drying dyers' samples. April 27th.

11,080.—Fourneau, E.—Manufacture of ortho-chloro-para-amino glycineamide phenylarsinic acid. April 25th.

11,052.—I. G. Farbenindustrie Akt.-Ges. —Production of orange vat dyestuffs.

Specifications Published.

269,624.—Hunt, A. P.—Process of making a self-preserving acid milk product especially adapted for the lower animals and the product thereby obtained.

269,624.—Hohn, F.—Process for the production of a chloride capable of reaction from pinene or purified turpentine oil.

269,647.—Newbery, G., and May & Baker, Ltd.—Manufacture of unsymmetrically acylated amino derivatives of arylarseno compounds.

269,661.—Simonis, O., and Liquid Air, Ltd.—Liquid air oxygen-producing plant.

246,842.—Bath, C.—Process for the production of 2-amino-5-iodypridine.

Abstract Published.

267,536.—Recovering caustic soda. Appareils et Evaporateurs Kestner, 5, Rue de Toul, Lille, France.

Caustic soda is recovered from the residual lyes produced in viscose and other artificial silk manufacture by rendering the alkali insoluble, for example by treatment with carbon dioxide. If the lyes are kept cool while the carbon dioxide is introduced crystals of hydrated sodium carbonate are obtained but if the temperature is allowed

to rise, the bicarbonate is precipitated when the lye is subsequently cooled, the *hemicellulose remaining* in solution in each case. The crystals are separated and dissolved in water, and after boiling, in the case of the bicarbonate, causticised in the usual way.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

THEOSOLBRAND.

477,686.—Chemical substances prepared for use in medicine and pharmacy.— H. R. Napp, Limited., 3 and 4, Clements Inn, Kingsway, London, W.C.2. May 4th.

FAIRYBELLE.

477,447.—Chemical substances prepared for use in medicine and pharmacy, but not including any goods of a like kind to any of these excluded goods. — Herbert Temple, 145, Cheapside, London, E.C.2. May 4th.

DIMOL.

478,962.—Chemical substances prepared for use in medicine and pharmacy.— Dimol Laboratories, Limited, 40, Ludgate Hill, London, E.C.4. May 4th.

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A SELECTIVE DISPLACEMENT OF 0.0153A IN X-RAY SPECTRAL LINES. PART VI.

By F. H. LORING.

In the *Chemical News*, 1927, CXXXIV., p. 291., an attempt was made to show a simple numerical relation between Δ_H and the displacement value 0.015253A, as discussed in these columns recently, the part here being a further continuation of this series of studies.

In observations of this kind one is faced with apparently simple and suggestive relations, which may turn out to be chance coincidences, especially since no theory can be advanced to support such relations.

There are two methods of procedure, *viz.* :— To discard any relations that are not supported by a large amount of reliable experimental evidence; or, to press a few consistent relations to a limit, hoping that there is something behind them which in time might lead to their rational interpretation. The latter procedure is, of necessity, here adopted.

From the preceding part (V) it will be remembered that the following values were involved :—

h = 6.556×10^{-27} (see below)
c = 2.99796×10^{10}
R_H = 109677.70
e = 4.779×10^{-10}
Δ_a = 0.0152532
Δ_H = 0.0152532 × 24 = 0.3660766*
Δ_H = $16\Delta_H$ = 5.8572256

In arriving at the above values, h was taken as 6.550×10^{-27} at the outset : the *starting* value. This might imply that h was slightly variable; but, it is beyond the writer's experience to suggest that such should be the case. This feature will be referred to again below.

It will be noticed, however, that the above value for Δ_H, multiplied by 800 (see below) gives the value 4685.780, which agrees well with the He line λ 4685.81 (4685.81 Fowler; 4685.808 Paschen). This is another coincidence that may or may not have a significant interpretation.

It is of interest, nevertheless, to press on with these relations. Assuming, therefore, that 6.5560×10^{-27} is the true value for h, and that the above values for e, c, and R_{inf} (= 109738) are also true values, then it is possible to calculate from these certain constants involved in such matters. Therefore, making use of the well-known equation for evaluating h, following L. Flamm (*Phys. Zeit.*, 1917, XVIII., p. 515; or, see Sommerfeld's "Atomic Structure and Spectral Lines," 1923 (Methuen), p. 527)—

$$h = [(2\pi^2 e^5)/(R_{inf} c^2 (e/m))]^{\frac{1}{3}}$$

In this case e/m is taken as 1.768×10^7, and the other constants as given above, h comes out at 6.559×10^{-27}, which is not in exact agreement with the value 6.556×10^{-27}.

* This value obtained by the equations given in Part V. The last decimal figure is not necessarily in co-ordinate agreement.

Therefore, using the equation given by Sommerfeld (*loc. cit.*) p. 526—

$$R_{inf} = [2\pi^2(e^2/h)^3] / [e(e/m)c^2] = 109891.0$$

Inserting this ' infinity ' value in place of the generally-accepted one above, when using again the former equation h comes out at 6.5560×10^{-27}, as the equations are derivable one from the other. The following constants are consequently consistent amongst themselves if the table is taken in two sections; but this is not a conclusive argument as experienced workers will know.

Δ_a	=	0.0152532
Δ_H	=	$24\Delta_a$ = 0.366076
Δ_{He}	=	$16\Delta_H$ = 5.8572256
HeII	=	$8\Delta_{He} \times 10^2 = \lambda$ 4685.780
h	=	6.5560×10^{-27}*
c	=	2.99796×10^{10}
e/m	=	1.768×10^7
e	=	4.779×10^{-10}
R_{inf}	=	109891.0

* $\Delta_a^{-1} \times 10^{-28} = h = 6.5560 \times 10^{-27}$

The 2nd, 3rd, 4th, 5th, 6th, 7th, and 8th line values are within the present-accepted errors of determination. The 1st, 2nd, 3rd and 4th will be referred to as *ideal values.*

It will be seen that in the cases of e/m and e the higher limiting values are selected. R_{inf} is, however, too high if the present-published value is the correct one within a small error in, or next to, the decimal region. The difference between the two values is 153.

Now to make h at the outset (see above and also Part V.) the same as at the finish* an alteration in at least one constant would be necessary; and judging from the larger value of R_{inf}, the particular constant might be R_H, having regard (partly, at least) to Michelson's new determination of the velocity of light (c), which is slightly lower than the best value hitherto used. The new value (c), is introduced throughout these later studies. In other words, R_H, *as used here* would, obviously, have to be larger if 6.5560 is the starting value when keeeping to the other constants as above given.

The question, however, might be raised: are all the so-called constants absolutely constant? Or, stating it another way, are the experimental conditions involved such as to permit of using some of the above constants as absolute or invariable quantities? Or, again, the experimental conditions would have to be taken into account, and it is only to be expected that experienced workers could decide such matters.

It must be remembered that these relations involve passing from an apparent X-ray phenomenon to purely optical phenomena. This is supposed to be a legitimate procedure, but, in the absence of more knowledge of the processes involved, a correcting factor or constant may have to be applied, which is represented in connection with one constant (see above) as $\Delta_a \times 10^4$—to give an illustration that is a guess. Optically Δ_H tends to be slightly less than the X-ray result would indicate, and this points to the same idea. In fact R might vary in some systematic way connected with multiples of some unit; the mass of the atom and the relativity effect, etc., are still factors that could possibly interpret such difference constants.

Concerning certain delta multiplying numbers (1/8, 1/24, 1/48) and other relevant matter, the reader may consult N. R. Campbell's " Modern Electrical Theory: Chapter XV. [separate vol.] Series Spectra," 1921, pp 87, 88.

Attention should again be drawn to the above values being calculated so as to give figures extending well into the decimal region. The reason for this is obvious when dealing with so many operations, but the possible significance of the values is not necessarily enhanced thereby.

In conclusion, it will be seen that the values in question are seemingly near enough to support the ideal values. That is to say, to make it possible to readjust the constants and get a thoroughly sound agreement throughout; but the writer is unable to find any satisfactory theory underlying the new relations in question. It is, of course, understood that the Rydberg constants are very accurately known from optical spectra, and any departure therefrom would not be regarded favourably. Be this as it may, the relations above shown are presented in the most favourable aspect as connected with the ideal values, and it would not do justice to the scheme of affairs to present it otherwise, at the same time both aspects are made evident by the two calculations. In other words, there has been no attempt to conceal the real difficulties and sufficient has been stated to suggest possible ways of reconciling differences in the respective constants involved by formula.

A STUDY OF THE MINERAL COMPONENTS OF ORGANISED MATTER.

By Maurice Copisarow, D.Sc.

(*Continued from Page* 308.)

Heavy Metals : Undoubtedly one of the most interesting elements in this group is iron, which universally distributed, is found in every cell and tissue. Though omnipresent, iron constitutes usually only an extremely small percentage of the mass of the organism. So in the human body there is about .095 per cent. of iron In higher animals the iron has a special significance as the integral constituent of the red corpuscles of the blood. In the hæmoglobin, the iron is in its organic form (about .366 per cent.) combined with the hæmatin. Iron is also found in protoplasma, brain (Zoleski), eggs, sperma, (Baussigmault), milk (Camerer), cornea, epidermis, especially in the joints.

Zaleski, in his analysis of the livers of various animals, obtained the following results :—

Liver of a—	%		
Dog ...	.0429-.0891 of Fe	(dry	sub.)
Horse ...	.0687-.0887 ,,	,,	,,
Rabbit ...	.0308-.04 ,,	,,	,,
Crayfish ...	.0432 ,,	,,	,,
Hare ...	.0439-.0469 ,,	,,	,,
Urchin ...	.7244-1.1835 ,,	,,	,,

A. Pastre and N. Pl. Floresco found that insects and reptiles have also no smaller percentage of iron. In all these cases iron exists probably in its organic form of combination.

Copper : This metal must be regarded as of special physiological importance for the lower animals, in which the copper plays the *rôle* of iron in higher animals. Constituting .33-.38 per cent. of the colouring matter, hæmocyanin, copper is essential for the absorption and transportation of oxygen in the organism of the reptiles, fishes, molluscs ,etc. Giunti, K. B. Lehmann and R. Dubois, give the percentage of copper for a certain number of lower animals as follows :—

		In 100 grms. of fresh substance	Mgs. Cu
	Anthea Cereus	......	2.35
	Hirudo Offic	....	—
	Stichopus regalis	......	2.83
	Asterias rubens	......	2.45
Crustaceans			
	Palæmon cerratus	...	2.50
	Clibanorius barbatus		6.00
	Astacus fluviatilis	...	3.07
Molluscs			
	Astrea edulis	....	9.65
	Astrea (white)	....	13.79
	Haliotis striata	......	4.00
	Pecten sacobaeus	...	4.71
	Helix formatia	......	6.11
Anthropod			
	Anomalavitis	....	3.8
	Blatta orientalis	......	4.3
Fishes	Clupea sardina	....	1.8
	Clupea harengus	......	0.25

M. Hentze showed that not only the blood, but also the liver from the invertebrates, contains a fair percentage of copper. So

				% of Cu
Octopus liver free from blood				.762
Eledone	,,	,,	,,	0.59
Sepia Offic	,,	,,	,,	0.32
				0.19

It is more than probable that the liver-pigment of the animals containing hæmocyanin is formed similarly to that of the animals containing hæmoglobin, thus suggesting that the copper exists in its organic combination. In higher animals the copper is apparently of secondary importance, being as a rule mostly localised in the bile and liver. In the human organism the amount of copper varies between 15 mg and 1.5 mg per kg. of liver and spleen. (Lehmann.)

Zinc : occurs chiefly in the lower animals. Combined with the proteids of the blood and certain muscles the amount of zinc exceeds in some cases that of copper. So in the Sycotypus Canaliculatus (dry mass), ZnO is to CuO in the proportion of 12.0 : 8.5.

Manganese : Accompanying iron, manganese is universally distributed in minute quantities. Its state of combination and biological importance are stil lunknown. It is specially concentrated in the uterus of birds, also feathers and nails. (Bertrand and Medigreceanu).

Aluminium : is found in certain cases in the animal world [(0.03 gr. Al_2O_3 per kg. of the dry substance of a new born child. (Soldner and Camerer)]. Its localisation and *rôle* are unknown.

Lead : may be mentioned for its considerable pathological effect. The traces found in the liver, spleen, nails, hair, etc., have to be, according to Meillère, attributed to adventitious introduction, and not regarded as a constant ingredient. It is interesting to note that in the case of serious nervous disorders following lead-poisoning, the lead was found to be deposited in the brain and its spinal prolongation.

Alkalis : Potassium and sodium are by far the most important and widely distributed elements from the alkaline group. In most cases they occur in the inorganic form as : chlorides, phosphates, sulphates, carbonates, fluorides, etc. Potassium and sodium resembling each other in the chemical properties not only play quite different *rôles* biologically, but are almost antagonistic to each other. (Jac. Loeb.). Whilst sodium is located in the animal fluids; potassium on the contrary, is concentrated in the cells and tissues, thus having a different sphere of influence. The micro-chemical investigations of A. B. Macallum showed that the potassium is confined only to the cell protoplasma, whilst the cell nuclei are free from potassium. No potassium was found in the neurons or nerve-cells.

It is for students of bio-genetics to study the striking fact of the preponderance of sodium over potassium in the lower animals, and in the higher while young or in the embryonic state. The ashes of Helix pomatia and of Crustacea contain sodium 10-12 times as much as potassium.

The potassium and sodium contents of the blood especially of the serum, has been shown by E. Abderhalden and C. Schmidt to be of a constant character for every species of the higher animals independent of the kind of food. The same applies to the milk of mammals.

Lithium : As a regular constituent, we can mention also lithium, which was found by Hermann to be present in many animal organs, especially in the lungs of man and calf. Chittenden found it in the muscles of the Hippoglossus Americanus, whilst Peroni and Schiaparelli found not only lithium, but also traces of caesium and rubidium to be present in urine.

Alkaline Earths : Calcium in virtue of its quantity and wide sphere of distribution, occupies the foremost place amongst the inorganic, or rather, mineral components of the animal kingdom. There is no animal organism, no organ, no cell, where calcium could not be found, while in the animal ashes it has the highest percentage. The calcium-salts have a double significance or function :—

(1) An active; and

(2) A passive one.

(1) Calcium serves all through the animal kingdom, with the mere exception of the lowest species where calcium is substituted by silicon, as the basis for the skeletons, covers, shells, etc., thus giving rigidity, stability and protection to the organism.

(2) Calcium is the element required by every cell to continue the functions of life. The calcium is met with mainly in its inorganic form, as phosphates, chlorides, sulphates. This becomes evident when we notice that by far the greater part of calcium is present in its passive form. The state of combination of calcium in the cells is still unknown. The nuclei of the cells contain more calcium than the surrounding protoplasma, while the cerebellum is richer in calcium than the cerebrum. As in the case of all other minerals, the percentage of calcium varies with the age of the organism, decreasing gradually in its active state. The amount of CaO in various tissues is given by Stalzner, Krüger, Toyonaga and Aron as follows :—

In 1,000 parts of fresh substance.	Gr. of CaO
Muscles	0.05-0.08
Blood	0.06
Brains	0.08-0.12
Lungs	0.14
Heart	0.22
Liver	0.15-0.3
Kidneys	0.08
Pancreas	0.1 -0.2

Magnesium : accompanying calcium, is widely distributed. Its relative amount can be clearly seen from the following table, constructed according to the results obtained by M. Tayonaga and J. Alvy :—

Dog			Relatively Ca : Mg. Horse	
Brains	0.19-0.33	... ...	0.2 -0.3	Mg>Ca.
Muscles	0.54-0.60	... ...	0.33	
Heart	0.76-0.81			
Lungs		... ...	1.2	Ca>Mg
Kidneys	1.8			
Blood Serum	2.7 -3.3			
Liver	3.6 -3.9	... ...	0.9 - 1.0	
(Ditto Calf and Pig.	Man 22.5)			
Pancreas		... ...	4.05	
Lactic-glands		... ...	4.67	
Spleen	6.2 -7.5	... ...	6.79	
Hair	9.2-12.7			
Bones	31.7 -46.6			

Amongst other elements found in traces, we should mention strontium, discovered by Butschli in the skeleton of the Prodactinclius and certain shells, then follows barium, cerium, lanthanum and didymium, which Cassa, Newmann, Linnossier succeeded in indicating.

And lastly, though not of least importance, can be mentioned radium. Accumulated evidence indicates unmistakeably the presence of radium in the organisms. So Lazarus-Barlow (*Proc. R.S., B.* 578, 1912), gives the following data :—

Radium in Some Carcinomatous Tumours.

Spheriodal cell carcinoma, axilary glands to breast	secondary	1.08×10^{-8} mgs.
Primary spheroidal cell carcinoma,	breast ...	0.188×10^{-8} ,, **(at least)**
Primary squamous cell carcinoma,	tongue ...	3.94×10^{-7} ,,
,, ,, ,, ,,	cervix ...	2.73×10^{-5} ,,
Standard of comparison	...	(1.57×10^{-7} mgs.)

All permeating water can be considered, of course, as an inorganic constituent of organisms, its percentage and distribution in the ainmal organs can be seen from the following table, drawn up by Botazzi-Baruttau, Volckmann and Bischoff :—

	% H_2O
Teeth	10.0
Skeleton	22.0
Fats (tissue)	29.9
Elastic tissue	49.6
Liver	69.6
Brain, white	70.0
Muscles	76.0
Spleen	76.0
Thymus	77.0
Pancreas	78.0
Connective tissues	79.6
Heart	79.3
Kidneys	83.0
Brains, grey	85.8
Blood	79.1
Bile	86.4
Milk	89.1
Tears	78.2
Saliva	99.5
Sweat	99.5

The Mineral Matter of Vegetables.

Before dealing with facts and particular cases as illustrations, we might indulge in some generalities. From the very fact that the vegetable kingdom is a kind of an active intermediary between the inorganic and animal world, or expressing it more generally, as it is one of the links in the chain of circulation or evolution of matter, it is more than reasonable to expect to meet there all existing elements, subject, of course, to certain limitations by the biochemical and physiological requirements. Now we must draw attention to a fact in itself significant and remarkable, namely, the progress of the persistency of certain elements in more or less definite proportions as we ascend the scale of species. The more developed and complex is the specie, the greater is its resistance to the influence of environment or rather to the change of environment, its functions becoming more specific. Whilst the mineral matter of the Thallophyta, especially the Schizomycetes, varies greatly with the culture medium, the Saccharomycetes, Diatomaciae, Ascomycetes, Characeae, Fucaceae, Lichenes,

Basidiomycetes, and still more the second and third group of the Cryptogams, the Barophyta, the Steridophyta, not to speak of the Phanerogams, become less and less indifferent to the variations of conditions and surroundings.

The physiological and bio-chemical requirements becoming more and more important, indicate the localisation and specialisation of functions, a greater characteristic individuality, a kind of material "ego," applied to groups, classes and species.

Beginning with the lowest organisms the bacteria (Schizomycetes), the analysis of the ashes of Bacillus Prodigiosus and Xerosebacillus (Köpper) Tuberculli Bacilli (Scheinitzi and Dorset) and Rötz-bacilli (Kresberg, etc.) show the presence of K, Na, Ca, Mg, P, Cl, Si ,etc., the quantity of which varies with the culture-medium. The study of the bacteria reveals in a most extraordinary manner the dependence of at least some of them, on the mineral world, overshadowing in certain cases even the Carbon-compounds. We have ground to believe that in the cases of iron, sulpho- and nitro-bacteria, contrary to the processes known to us from the general world of organisms, organic substances do not serve as the substrat of oxidation and accumulation of energy, but the inorganic salts and compounds. The study of the importance of mineral matter in bacteria will some day serve as the ground for the investigations of the *rôle* of mineral matter in other organisms, where it is less strikingly manifested. In this field of research we must mention the names of L. Pasteur, Knieriem, A. Meyer, Hoyer, Cohn, Jaksch, and C. Nageli. The biological experiments of Pasteur, Mayer, Villé, Vinogradsky on Saccharomycetes showed the qualitative and quantitative dependence of the mineral matter of the latter on the culture-medium.

Mulder, Raulin, Nageli, Loeb and others proved the vital importance of the mineral matter of the culture-medium on the whole group of Thallophyta, though the mineral matter can be varied in certain limits quantitatively as well as qualitatively without apparent injury to the organisms. So the salts of potassium could be substituted by those of rubidium and caesium, of calcium by similar salts of barium, magnesium, strontium, etc. The latest investigations show that substitutions have influence on the functions of the organism.

Arsenic: The distribution of arsenic in the plant world in general (Jadin and Astruc). In sea-weed the proportion of arsenic is greatest where chlorophyll is least; this is the opposite to the relation existing in land plants (Marcelet). Of some interest is the influence of arsenic on the vegetables. Orlowsky found that arsenic in small doses has a stimulating effect on the growth of vegetables. Gosio experimenting on Penicillium glaucum, Aspergillus glaucus and Mucor Mucedo found that an admixture of .005-.01 per cent. of As_2O_3 had a most remarkable effect on the plants. There appeared a secretion of a fœtid fluid, which contained combined arsenic. They found further the sulphide of arsenic was not assimilated by the organism, the copper salts of arsenic with difficulty, whilst arsenates and arsenites quite easily. As to the state of combination of the arsenic in the secretion, the conclusions were based on the analogy with the with the salts of tellurium and selenium occuring in animal (Tellurmethyl, Selenmethyl) (Czapek and Well, Hofmeister).

Note.--The representation on Page 305 of the *Chemical News*, this volume, May 20, where (a) the mineral world; (b) flora; and (c) fauna may be expressed in the form of *circles* coming in contact with each other at continuously varying points.

Further, it is interesting to note that the study of the mineral components of organised matter has a close bearing upon the problem of diet. Recognising mineral matter as a normal constituent and important factor in all metabolic changes, we must, in the study of diet, give it a place equal to that of carbohydrates, fats, proteins, and vitamins.

(*To be Continued.*)

THE CANADIAN MINING INDUSTRY.

The Dominion Bureau of Statistics reports that, in the operating mines, quarries and smelters in Canada there are upwards of 65,000 persons employed. This number does not represent the total extent of employment in the mining industry as there are no records available of the numbers engaged in prospecting and general development work on properties that have not reached the producing stage nor does it include any allowance for those persons who are engaged in the subsidiary industries.

CAPITAL EMPLOYED.

Investment in Canadian mines amounts to approximately $632,075,000; of which $290,534,965 is invested in metal mining and metallurgical works treating Canadian ores; $253,023,646 represents the investment in non-metal mines and $88,516,534 the cost of properties and plants producing structural materials and clay products.

ARSENIC PRODUCTION IN CANADA, 1926.

Arsenic production from Canadian ores amounted to 5,074,677 pounds, including sales of white arsenic amounting to 3,984,217 pounds and the recoverable arsenic contained in export shipments of concentrates and residues, amounting to a further 1,090,460 pounds of white arsenic. The value of the total Canadian production was $146,811 in 1926 compared with $130,302 for 3,434,137 pounds sold in 1925. The average price of arsenic on the New York market in 1926 was 3.5 cents per pound as against 4.66 cents in 1925.

The greater part of the Canadian production of arsenic is obtained from the South Ontario smelters as a by-product from the ores of the cobalt district.

CANADIAN COKE PRODUCTION.

The output of coke in Canada during 1926 totalled 1,909,578 tons as compared with 1,471,116 tons in 1925. Disposition of coke by the producing plants showed that during the year 248,113 tons were used in the coke plants, 901,244 tons were delivered to associated metallurgical works, and the balance, 767,940 tons was sold chiefly for domestic and foundry uses. Imports of coke into Canada during the year totalled 988,034 tons, and represented an increase of 16 per cent. over the total of 852,427 tons brought in during the previous year.

CANADIAN FELDSPAR PRODUCTION.

Feldspar production in Canada advanced 19 per cent. in quantity in 1926 to a total of 34,382 tons, as compared with 28.681 tons produced in 1925. The value of the shipments during the year was $292,205, or $8.50 per ton.

GRAPHITE PRODUCTION IN CANADA.

The increase in shipments of graphite noted during the first half of 1926 was continued in the last six months and the total for the year was reported at 2,592 tons, worth $188,511.

PRODUCTION OF NATURAL GAS AND PETROLEUM INCREASING.

The two great natural gas producing regions of Canada, the Province of Alberta and the western peninsula of Ontario, both increased their production in 1926, accordin gto preliminary figures now available. Alberta maintained its lead over the older established Ontario field with a production of 10,418,697 thousand cubic feet, valued at $3,041,100. The 1925 production was 9,119,500 thousand cubic feet, valued at $2,752,545. In Ontario, 7,364,039 thousand cubic feet of natural gas was produced in 1926, valued at $5,068,911, representing an increase from 1925 of 323,474 thousand cubic feet, and an increase in value of $1,180,514.

Alberta also leads in petroleum production with 217,088 barrels in 1926, valued at $906,968, compared with 183,491 barrels, valued at $845,394 in 1925. Ontario's production fell off slightly in 1926 at 136,971 barrels, valued at $376,832, a decline of 6,473 barrels, attributed to natural decline in the oil fields.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on Thursday, May 19 :—

Studies of the Mercury Band-Spectrum of Long Duration. By LORD RAYLEIGH, F.R.S.

An improved method is worked out for obtaining the mercury band spectrum of long duration. The stream of vapour is excited by a current of less than a milliampere, using a hot cathode. It is then observed spectroscopically after leaving the region of discharge. As in previous investigations, the resonance line 2537 is associated with the band spectrum, but the resonance line 1850 is absent.

The important divisions of the band spectrum are :—

(*a*) The band at 2345, with attendant bands of shorter wave-length.
(*b*) The resonance line 2537, with bands within a few Angströms of it.
(*c*) The fainter maximum at 2650, and a series of flutings which are made out with difficulty but seem to be associated with it. Approximate wave-lengths of these bands are given.

(*d*) The broad maximum at 3300.
(*e*) The broad visual maximum.

It is found that when the vapour is examined *after excitation* all these features decay *pari passu*. The actual time taken to decay to half intensity under the conditions is measured as $1.82-10^{-3}$ second.

If the excited stream of vapour is passed through a tube locally heated to redness, the band (*e*) is extinguished, (*a*) and (*c*) are slightly weakened, but (*b*) and (*d*) are almost unaffected. As the vapour passes on to the cold part of the tube the visual light (*e*) reappears to some extent, and (*a*) and (*c*) tend to regain their intensity relative to (*b*) and (*d*).

The Spectrum of Ionised Nitrogen (N II). By A. Fowler, F.R.S., and L. J. Freeman.

In continuation of a previous investigation of the spectrum of ionised nitrogen (N II), observations have been made over the range λ 6836 to λ 830. Of 340 lines recorded in this region, about one-half have now been classified, and of the remaining lines more than 100 are very faint. The spectrum is built up from triplet and singlet terms, the absolute values of which have been determined with the aid of a sequence of three $3p' - 3p$ multiplets.

The scheme of terms deduced from the Heisenberg-Hund theory of complex spectra has greatly facilitated the analysis of the spectrum, and the results are in excellent agreement with the theory. Of the 19 deepest terms predicted by the theory for transitions of a single electron, complex terms being counted as one, all but one have been identified. The term 1^3P_0 recently identified by Bowen from a multiplet at λ 671 is probably the deepest, its value being 238850, corresponding to an ionisations potential of 29.5 volts.

A few multiplets which appear in the spectrum are attributed to double electron transitions.

The Hydrogen Band Spectrum: New Band Systems in the Violet. By O. W. Richardson, F.R.S.

This paper describes the Q branches of some band systems which include much of the strength of the secondary hydrogen spectrum when this is excited by direct electron impact on the H_2 molecule and there are no additional complications. The final states of the bands appear to be the same as the initial states of the Lyman bands in the far ultra-violet (the B states of Dieke and Hopfield). All the bands are degraded towards the violet. The strongest band system. denoted by A, has its nucleus ($0\to 0$Q (1) line) at λ 4633.95(9). The Q branch of the $1\to 0$ band is the series 20 Q(*m*) of Richardson and Tanaka. Fourteen of the A bands have been located, with the lines showing intercombinations of the same type as the *a* bands. There is a less strongly developed band system (B) with its nucleus at 3684.38(2) and a few Q(1) lines of a system (C) with its nucleus at 3368.47(0). A, B and C all have the same set of final states. The null frequencies of each band system, calculated on the wave-mechanics, satisfy the Hicks formula

$$v(m) = 33727.12 - \frac{109678.3}{\left(m - 0.8926 + \frac{0.09213}{m}\right)^2} . \quad m = 3, 4, 5.$$

The terms are 2S = 33727.12, 3P = 12676.47, 4P = 7087.66, 5P = 4514.14. They are very close and similar to the corresponding terms of the principal series of He *singlets* but rather larger.

ROYAL INSTITUTE OF PUBLIC HEALTH.

We have received the full programme of the Congress which is to be held at Ghent from June 1, to June 8. This will be an interesting and important meeting, and we learn that the Committee will give a hearty welcome to anybody interested in public health.

General Information.

The Reception Room, which will be situated in the Palais des Fêtes au Parc de la Ville,, will open on Tuesday, May 31, at 9.30 a.m., and will remain open on each day of the Congress from 9 a.m. to 5 p.m.

Delegates and Members are requested to register without delay on arrival in Ghent. On presentation of the Membership Ticket a Badge will be given.

The Meetings of the Congress will be held in the Palais des Fêtes.

The Inaugural Meeting will take place on Wednesday, June 1, at 10.30 a.m., in the Palais des Fêtes at which Delegates are requested to wear uniform, academical or municipal robes, etc.

The Sections will meet daily during the Congress from 9 a.m. to 12 noon, and from 2 p.m. to 4 p.m.

There are to be receptions, sectional meetings, excusions, banquets, and numerous entertainments. The cost of the trip, first-class, per Sir Henry Lunn, Ltd., is 11 guineas; or £2 10s. less to those who wish to travel third-class in England and saloon on steamer.

THE CHEMICAL SOCIETY.

Thursday, May 19.

New Developments in the Study of Acid Catalysis. The Catalytic Catenary. By PROF. H. M. DAWSON.

The long continued acceptance of the view which ascribes the catalytic activity of acids entirely to the hydrogen ion is largely due to the circumstance that this theory is in approximate agreement with a considerable body of facts. Outstanding anomalies, such as are presented by the salt effects observed in the catalytic action of strong acids, have been accommodated by the introduction of *ad hoc* hypotheses.

More detailed and accurate investigations of acid catalysis led subsequently to the idea that the undissociated acid also plays the part of a catalyst. Notwithstanding the very strong evidence of the dual theory of catalytic activity, it has received comparatively little attention. On the other hand, the suggestion that the facts may be explained in terms of variations in the activity of the hydrogen ion seems to have had undue weight attached to it. It is possible that such variations cannot be ignored, but there can be little doubt that the deviations from the simple hydrogen ion theory are mainly due to the circumstance that the observed catalytic effects are not entirely due to the hydrogen ion, but represent the joint action of hydrogen ions, acid anions and undissociated acid molecules.

If a comparison is made of the catalytie activities of mixtures of a weak acid and its corresponding salts, represented by the formula cHA + xMA (where c is constant and x variable), it will be found very generally that as x increases, the reaction velocity falls, reaches a minimum and then increases. If the velocity is plotted against p_H, a curve of catenary type is obtained.

The dimensions of the catenary curve and the position of its minimum (iso-catalytic) point vary with the concentration of the acid. The complete series of catenaries yields a catalytic space model in the form of a catenary surface, by means of which it is possible to represent the catalytic behaviour of all possible mixtures of an acid and its salts.

The catalytic catenary may be given a generalised form ,for if the hydrogen ion concentration and the ionic reaction velocity for any acid-salt mixture are expressed in terms of the corresponding quantities which are characteristic of the isocatalytic mixture with the same acid concentration, the connection between the reduced ionic velocity (r) and the logarithm of the reduced hydrogen ion concentration (h) is given by

$$r = \cosh h$$

This equation contains no specific constants, and is therefore independent of the nature and concentration of the catalysing acid, of the temperature, of the solvent and of the nature of the catalysed reaction. It is the equation of the general catenary, and is found to be consistent with known facts.

For a given reaction the catalytic activities of the pure acids are represented by points on the general catenary, the position of these points being determined by the relative magnitudes of the velocity coefficients of the hydrogen ion and the undissociated acid anion.

The considerations underlying the general theory have been applied successfully to the phenomena associated with reaction velocity in isohydric solutions and in buffer solutions, and also to the phenomena of auto-catalysis. Kinetic methods have been described for the determination of ionisation constants, of velocity coefficients which cannot be obtained by direct measurement, and of the degree of dissociation of water. The general results are such as to offer a very comprehensive picture of the catalytic relations involved in acid catalysed reactions, and throw new light on the nature of acids and their relation to the so-called bases.

ROYAL SOCIETY OF ARTS.

THE PROPAGATION OF ELECTRIC WAVES.

By J. E. TAYLOR, M.I.E.E.

(Superintending Engineer, Post Office Telegraphs, South Midland District.)

(*Abstracted from the "Journal of the Royal Society of Arts.*)

As, year by year, new and important facts have emerged into the light of day in consequence of practical development and research in wireless communication, so it has become necessary to adapt explanations to fit the latest results, and, if possible, to

reconcile the basic theory with the new turn of events.

From the earliest days the progress of the art has been marked by a curious succession of unforeseen developments. Some of the more salient of these will be referred to.

At its earliest inception the potential utility of electric waves as a practical method of communication was looked at askance. Such waves were held to have a very limited scope as compared with heliographic, semaphoric and such like methods making use of rays of light. The curvature of the earth alone, would, it was predicted, impose a quick limit to the range over which it would be found possible to utilise them.

The immense step forward made when Marconi succeeded in transmitting signals consisting of the letter " S " steadily repeated, across the Atlantic from Poldhu, Cornwall, to St. John's, Newfoundland, came as a profound surprise. The announcement was, in fact, received with marked incredulity and many were content to assume that atmospheric electrical disturbances had been mistaken for transmitted signals; it being then sufficiently obvious that diffraction alone could not explain the result. In due course corroboration was forthcoming by transmission to ships at comparable distances and it was then realised that the explanation must be moulded to the facts. In the course of these long distance developments, it became evident that the transmission conditions *en route* varied from time to time, more favourable conditions existing at some periods and seasons of the year than at others. Prominent among these were the fluctuations of signal strength as between the daylight and night conditions, the periods of most favourable transmission being obtained during certain hours of darkness. This fact indicated an effect of solar radiations on the atmosphere as being at least a contributing factor in the variations. During daylight hours the solar rays would produce an ionisation or state of partial conductivity of the atmosphere facing the sun, especially in the outer layers, which would render the air less transparent to the waves by day.

Following on the long distance achievements, expressions of opinion as to the monopolisation of the ether by transmitters radiating the large amounts of power used in communicating long distances, were circulated. Such transmitters would shout down or " jam " the smaller stations, thereby curtailing the utility of wireless communication in general. Tuning of receivers to different wave lengths was prophesied to be comparatively ineffective in mitigating the evil. Fortunately these predictions were not confirmed. The tuning was found to be much more effective than was anticipated whilst, also, improvements in methods of transmitting and receiving gave superior selectivity. The invention of the Poulsen arc method of continuous wave transmission carried this selectivity by tuning to a still further degree of refinement.

In the succession of unforeseen developments the detrimental effects of unfavourable electrical conditions of the atmosphere figure largely. These consist not only of the day and night variations of signal intensity and the ordinary static disturbances, but also transient " fading " of signals when they pass through comparatively slow but very pronounced variations in strength. A distinct effect of the latter character is the " sunset effect," which usually holds up communication entirely for a period each day on long distance work with long waves. Yet another effect in this category seems to be asserting itself in that it appears to be extraordinarily difficult for waves to pass over the Polar regions of the earth.

One of the accepted doctrines of wireless communication is that long ranges over sea are necessarily very much more easily obtained than over land, because the specific resistance is less in the former case. This anticipation has been realised in practice only to so limited an extent as to occasion much surprise.

On the laws governing variation of range of communication with transmitter antenna current, wave length and effective heights of antennæ, many attempts have been made to formulate a mathematical expression to pre-determine the type of station required to ensure commercial communication. No reliable expression has yet been evolved applicable to long ranges. In nearly every case the expressions have been based on the assumption that rectilinear wave propagation is involved plus a hypothetical deflecting agency. Since they also assume that long waves are required for long ranges they naturally fall to pieces against short wave results.

Perhaps the least expected result of all is the recent short wave development. Whether by beam or broadcast, it has been shown that extra short waves can be used over the maximum distances available on this planet, when generated by only a small

fraction of the energy necessary with the older long wave methods, and that they are not subject to the same day and night variations not to the same degree of static interference. These results conflict with prevailing theoretical views.

It is one of the objects of this paper to get the theoretical views better adjusted if possible. With that idea one point in connection with the assumed ionised layer in the atmosphere will be cleared up before proceeding further. This region has become known as the " Heaviside Layer." Now Heaviside would have been the last man to admit its validity in the sense in which it has been applied. The late Mr. Oliver Heaviside was a mathematical and physical genius of a very high order and it is due to his memory to have this matter put right. To make the issue clear the so-called Heaviside layer is taken to be defined as a supposed permanently ionised region existing in the upper atmosphere, without the assistance of which the bending of electric waves round the curvature of the earth could not be accomplished. Now if the article written by Mr. Heaviside ,in 1902, for the *Encyclopœdia Britannica* and incorporated in Volume II of his Electromagnetic Theory, be referred to, it will be seen that the whole tenour of the article turns on the ability of waves to accommodate themselves to conducting surfaces, and that he clearly indicates that they climb around the earth's surface quite apart from whether or not an ionised layer exists. The relevant part of the article reads as follows :—

> " This guidance is obviously a most important property of wires.
>
> There is something similar in ' wireless telegraphy.' Sea water though transparent to light, has quite enough conductivity to make it behave as a conductor for Hertzian waves, and the same is true in a more imperfect manner of the earth. Hence the waves accommodate themselves to the surface of the sea in the same way as waves follow wires. The irregularities make confusion, no doubt, but the main waves are pulled round by the curvature of the earth, and do not jump off. There is another consideration. There may possibly be a sufficiently conducting layer in the upper aid. If so, the waves will, so to speak, catch on to it more or less. Then the guidance will be by the the other."

Clearly all that Heaviside meant to convey by his reference to a possible conducting layer was that the existence of such a layer might limit the upward expansion of waves and so conserve the wave energy.

It must have occurred to many others besides Heaviside that the rectilinear propagation view could not be reconciled with the everyday aspects of wireless communication, as exhibited by the ability of the waves to reach aerials situated in the back yards of houses in large cities, or of their faculty of accommodating themselves to large and abrupt changes of level in the general contour of the land; in fact their obvious faculty of getting round, over or through thousands of obstacles which, on the rectilinear propagation view, should prove insurmountable barriers. If electric waves obeyed optical laws it would be expected that well defined shadows of imperative objects would be thrown, that valleys out of the direct line of propagation would not receive any radiation and so on. The wireless antenna itself has no good optical analogy.

It was considerations of this kind which led the writer to make the prediction which has since been amply confirmed, that the curvature of the earth would not impose a limit on range of communication. This, it may be remarked, was three years before Heaviside's article in the Encyclopaedia Britannica, in which he expresed practically equivalent views.

The guided wave view disposes of the necessity for invoking the assistance of an ionised layer in the atmosphere whilst it does not deny that some degree of ionisation may, and indeed must, exist, at least in the sunlight portion of the atmosphere and near the poles where it concentrates.

For purposes of electrical theory it is only the electrical aspects of matter that are of concern to us. Electric forces or electric fields can only be changed by interferene from other electric fields. Forces of any other nature are without effect. Hence in this connection matter may be regarded as entirely electrical in its constitution. It even appears probable that in empty space there exists a system or network of electric fields or electric stresses, not evident in the gross, which are perhaps systems of self-closed lines of force, and in virtue of which the propagation of electric waves through space is rendered possible. Magnetic force is embraced as being only a particular aspect of electric force whilst mass or inertia are likewise to be regarded as electric quantities. The atoms and molecules of matter consist of minute compound

systems of electric fields starting from protons and ending on electrons. These minute fields are immensely more intense than any electric fields artificially produced. It is these minute electric fields which are called into play and upon the re-adjustment of which depend the various electrical manifestions occuring in practical applications. To the way in which these fields can re-arrange themselves to produce a gross resultant effect we must look quite as much as to the motions of electrons. It has always been regarded as something of a mystery why a charge spreads or runs along a conductor and various views, which the author holds to be erroneous, have been expressed about deficits or electrons at one place and and surpluses at another and so on. The important fact appears to be that particular molecular field arrangement spreads, both in the dielectric and the conductor. The lines of force constituting the external field simply slip along the molecular lines of force in the conductor without pulling the charges or electrons along with them. Just as when a conductor is moved out of an electric field the lines of force join up and leave the conductor without pulling electrons with them, so the converse effect can take place that the molecular fields of the conductor join up with the external field when teh conductor is moved in, without electronic movements being directly involved. That is, the process by which an external electric field slips along a conductor primarily depends on the joining up of successive molecular lines of force with the external field. Only in so far as it is an imperfect one is there any loss of energy in this slipping process. This view is implied by Heaviside, where he draws a clear line of demarcation between "conducted" and "convected" currents and points out that the current along a metallic conductor is not a convected current.

So far as dielectrics (that is, insulating substances) are concerned, it is common ground that the molecular electric fields are self-contained, or at any rate stable, in their character. They are not prone to interfere with one another.

In electrolytes whilst the molecular electric systems are unstable the ionic systems are still stable in general, as in a dielectric. The result of the molecular instability is that the positive and negative ions are continually changing partners in the course of the normal molecular activity, evidenced as temperature. Apart from the application of electric stresses the interchange is chaotic, but when stress is applied the interchange becomes more or less organised, and an "ionic drift" is produced determining a deposition of positive ions at one pole where the stress is applied and negative ions at the other. The interchanging of ions in a substance constitutes "ionisation." The law of increase of conductivity with increase of temperature in electrolytes is obviously complied with on this view. The imposition of a drift on the normal chaotic interchange does not involve dissipation of energy. Only in so far as the interchanges are not suciently frequent to cope with the influx of fresh applied stress is there dissipation of energy. The insufficient rate of interchange results in certain molecules or molecular groups acting as dielectric molecules when they hold or trap parts of the applied stress and cause dissipation of energy in the electrolyte. The trapped energy accentuates the molecular motions and evidences itself as heat. Electrical energy is, of course, taken up in forming the new constituents of the electrolyte, but this is not energy dissipation.

In metallic conductors it is the minor electric systems in the ions, in other words, the atomic internal electric systems themselves, that are relatively unstable. For some reason the atomic fields of a metal are so constituted that electronic interchanges occur between neighbouring atoms. Each atom has, as it were, an outer range into which some electrons make excursions and returns. Those which make the more extensive excursions are liable to come into the range of neighbouring atomic fields when they exchange venue. Here again the interchange of electrons is normally chaotic but becomes in some small degree organised under the influence of an impressed electric field and the "electronic drift" is produced.

From what has been said in reference to electronic drift and electronic interchanges, it might be inferred that the function is to hand on electric charges. In the author's opinion the state of the molecular fields in the conductor *after* the handing on of the impressed electric force of the wave, and so put the molecular fields into a condition to conduct subsequent applications of impressed force. The assumption is that in conductors and dielectrics alike there exist available prepared stress paths for the transmission of wave fields. The interconnecting and changing electric fields of the molecules and atoms provide these paths. But whilst the disturbance of the molecular

field arrangement following the passage of impressed stress corrects itself in conductors it is not so in dielectrics. The electronic interchanges in conductors relieve the state of stress superposed on the molecular fields and so, to some extent, prevent the setting up of a counter stress or opposing E.M.F. In dielectrics the counter stress set up balances the impressed stress and prevents further influx. The correction in conductors comes about by field re-adjustments made possible by the electronic interchanges.

The molecular fields of conductors are self-restoring, those of dielectrics are not. This is the essential difference between the two. Wave conduction is equally present in both cases, but the conduction is transient in the dielectric because of the sustained opposing E.M.F. built up in it. The rapid decay of the opposing E.M.F. in conductors enables the conduction to appear as a continuous state.

In reality it is a very discontinuous state as referred to the separate molecules or small groups of molecules of the conducting substance under a continuous electric stress. Such a group is essentially dielectric in its character, but exhibits conducting intervals when it may be said to be perfectly conducting, because there are no dissipation losses occurring during these spasms of conductivity.

There is one other important theoretical deduction that will be mentioned. The slipping of electric waves along conductors by the interaction of molecular lines of force with the wave field must not be taken as implying that wave guidance by conductors is thereby brought about. With a perfect conductor the wave field would slip off at the first bend or curve. This would not be the case with an imperfect conductor, because the lateral electric field given out by the conductor produces a tilted resultant wave front. Now applying Poynting's theory which states that the direction of propagation is normal to the wave front, it follows that the wave propagation is diverted *towards the conductor*, the tilt being a forward one. This is, in the author's view, the effect which gives wave guidance in all its aspects and without which there could be no currents in wires. It also indicates that the practical engineer would have little use for perfect conductors. This leads to the question as to why then are not luminous waves guided by conductors likewise? The answer appears to lie in the inertia of the electron. The change in direction of the wave field in a luminous wave is so excessively rapid that it is unable to exercise any control over the movements of the electrons during the electronic interchanges. For these waves there is no absorption of energy by the conductor and hence no wave tilt. The full explanation however hardly concerns the present subject.

The extent of the wave tilt produced by resistance in broadcast transmission over the surface of the earth will vary chiefly with the distance from the source of oscillation, being very pronounced at short distances and becoming less as the annulus or ring of current at the surface expads outward until it is in general almost imperceptible at large distances, though never negligible.

Major irregularities of surface contour doubtless also give rise to wave distortion and interference positions, not only because of the indentions in the wave front, but by reason of partial reflection of waves where sufficiently steep gradients of surface are encountered. In such cases a part of the wave is reflected and a part climbs over the surface. The latter part will have its velocity of travel up the gradient retarded to an extent depending on the increase of wave tilt relative to the gradient, and will reach localities beyond with a retarded phase producing interference with wave rays arriving by routes with different characteristics.

It will be well at this stage to emphasise the essential differences between oscillations and waves. An oscillation is a wave source from which, as centre, the waves proper proceed in all available directions. The waves have a velocity of travel or propagation depending on the character of the medium in which the propagation is occurring. The oscillation or centre of disturbance remains fixed in position and has no velocity of translation. That is, it is not propagated, and is therefore sometimes called a standing wave. In a pure electric oscillation the energy oscillates between the electric and magnetic forms, corresponding to potential and kinetic energies in mechanical oscillations. The electric and magnetic fields are, therefore, 90 degrees out of phase. In a pure electric wave, on the other hand, there is no oscillation as between the two forms of energy. The electric and magnetic forces co-exist in exact phase and the wave energy is equally divided between the two. The oscillating field at the centre of disturbance merges gradually into the wave as the centre is

departed from. Until a true wave is formed the field has an oscillating component and a wave component. The one decreasing and the other increasing as the centre is receded from. So long as an oscillating component exists, to that extent the field acts as a source of additional waves sent out radially from any point in the field.

In regard to the comparatively recent discovery that extra short waves are not subject to the same day to night variations as the longer waves, the explanation is no doubt to be found in the fact that the wave base is so short as between its positive and negative extremities on the surface of the ground that the force exerted in an upward direction rapidly diminishes with distance above the base.

The further discovery that waves are practically unable to traverse the polar regions of the earth indicates an electrically defective atmosphere in those regions, which probably extends right down to the surface of the ground. If so, the effect will apply quite as much to short as to long waves. An electrically defective atmosphere in the polar regions is to be expected as a result of the concentration of atmospheric ionisation evidenced in the luminosity of the auroræ, combined with the probability that the ionic drift finds its way through the lower atmosphere to earth in the polar localities, whence it continues through the ground in the form of earth currents. This does not exclude the possibility that the ionic drift may sometimes find its way through the lower atmosphere in other localities, especially in mountainous regions.

Broadly speaking, it is the author's view that it is to the interaction of electric fields and their manipulation that we must learn to look for accurate fundamental explanations rather than to motions of electric charges or electrons, and that it is necessary to bear in mind that such electric fields are never created or destroyed, either in material substances or in empty space. It is only the organisation in some small degree of pre-existing forces that is possible. In material substances concentrations of these forces occur, but in empty space there are, apparently, no concentrations, and that is why it is suggested that the fundamental electric fields of empty space exist as closed electric lines of force. It is believed that a real insight into the mechanism of electric wave propagation is to be obtained only in this way. To adapt the mind to Nature's ways and to learn the language in which she is trying to convey her secrets to the intellect of Man, is as much, if not more, a necessity than the attainment of great mathematical skill in the problems of physics.

CORRESPONDENCE.

ELEMENTARY CHEMISTRY TEACHING.

(*To the Editor of the* CHEMICAL NEWS.)

Sir,

On looking through the questions set in Chemistry last July by the Joint Matriculation Board I notice one which reads: "Write the formula usually given to (*a*) quick-lime; (*b*) slaked lime; (*c*) bleaching powder." This question illustrates a too frequent laxity which occurs in the elementary treatment of the chemical composition of common commercial substances. Writers of elementary text-books are often remiss in this direction. Here are three substances, described by common names, which have no chemical significance, which start from a raw natural material of varying composition, and yet the candidates were asked to write formulæ for them. The examiner evidently had his doubts about the propriety of the question, for he inserted the word "usually," perhaps thinking of some of the lax elementary text-books.

The type of question set in examinations of the matriculation standard plays an important part in teaching in the schools. Old examination papers are worked over. A large number of boys and girls have seen and worked this question, and have now got the impression that these three commercial substances have formulæ. It is most important that questions should be set upon common materials, but they should be carefully framed so that candidates have no excuse for assigning a formula to anything but a definite chemical compound.

In the same paper there is a question of a volumetric character in which data are given in terms of the c.c., and the result is asked for in terms of the litre. When one considers that the definition of the litre does not now involve the centimetre, it looks as if an appropriately worded question or two would direct attention in the schools to precision in teaching the nature of the litre, and that its thousandth part is the millilitre (ml.)

Yours truly,

A. PRICE,
B.Sc., F.I.C., L.C.S.

Barnsley.
May 13, 1927.

NOTICES OF BOOKS.

Report of the Stone Preservation Committee. Department of Scientific and Industrial Research. Roy. 8vo., paper wpr.; pp. iv. + 34, with 4 plates. Price 1s. 3d. net. Postage extra.

While the problem of decay in building materials had long been recognised, it did not cause general concern until national attention was attracted, in the middle of the nineteenth century, by the rapid decay of the stonework of the Houses of Parliament. In recent times the trouble has become widespread in many parts of the country.

In December, 1922, the Department set up the Stone Preservation Committee to consider the best methods by which decay, especially in ancient structures, may be prevented or arrested. A report on the progress of the Committee's work is now published.

The Committee found that it was first necessary, for the prosecution of their work, to arrange for a thorough investigation of the various types of decay in relation to the character of the stone and the climatic and industrial local conditions. Broadly speaking, the study has two aspects (a) chemical, physical and geological, and (b) biological. It must be emphasised that owing to the difficult nature of the fundamental researches, speedy results cannot be hoped for. The description in the report of the technique devised for the study of thin sections of friable decayed stone may be of special interest.

FORTHCOMING EVENTS.

LONDON UNIVERSITY.

University College, Gower Street, W.C.1.

Thursday, June 2, at 5.30 p.m.—" Venice and the Political Thought of the Renaissance." A public lecture by Professor Edmund G. Gardner.

Wednesday, June 8, at 5.30 p.m.—" Experimental Vital Statistics." First of a course of three public Lectures by Professor Raymond Pearl, Director of the Institute for Biological Research, Johns Hopkins University, Baltimore. June 8, 9 and 10.

Thursday, June 9, at 5.30 p.m.—"Foscolo e Dante." A public Lecture in Italian by Dr. Camillo Pellizi.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

SUMMER MEETING AT NORTH-EASTERN CENTRE, 14-17 JUNE, 1927.

The Committee of the Centre (Mr. J. Rosen, Chairman) extend a cordial invitation to members and their ladies to take part in the Meeting.

REGISTRATION OFFICE.

A Registration and Information Office, with attendant and telephone, will be provided at the Central Station Hotel, Newcastle-upon-Tyne.

During the evening of Monday, June 13, the Banqueting Hall of the Central Station Hotel will be open to enable visitors to meet the Committees of the North-Eastern Centre and the Tees-side Sub-Centre, and to become acquainted with each other. Music and light refreshments .

ROYAL SOCIETY OF ARTS.

John Street, Adelphi, London, W.C.2.

Dominions and Colonies Section.—Tuesday, May 31, at 4.30 p.m.—" Spanish Morocco." By Señor Don Tomas Baldasano, LL.D., Caballero de Isabel la Catolica, London Correspondent of *Le Epoca* (Madrid). The Right Hon. The Earl of Selborne, K.G., P.C., G.C.M.G., will preside.

ROYAL INSTITUTION.

21, Albemarle Street, W.1.

Friday, June 3, at 9 p.m.—" Carlyle as an Historian." By George M. Trevelyan.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

12,189.—Boedecker, F.—Preparation of mono-ethyl ethers of protocatechuic aldehyde. May 6th.

11,994.—I. G. Farbenindustrie Akt.-Ges. Process of reducing aromatic amino compounds. May 4th.

11,998.—Chemische Fabrik auf Actien vorm E. Schering.—Manufacture aminometalmercaptosulphonic acid etc.

11,844, 11,845.—I. G. Farbenindustrie Akt.-Ges. — Manufacture of azo

—Manufacture of naphthalene, etc. condensation products. May 5th.

Specifications Published.

269,970.—Fabriek van Chemische Producten, abd Kraus, Dr. E.—Manufacture of sulphurised derivatives of phenols and naphthols and their application as mordants.

247,932.—Patart, G.—Method for simultaneously synthesising methanol and liquid hydrocarbons.

247,177.—Patart, G.—Method for the synthetic production of higher alcohols.

262,382.—Darco Sales Corporation.—Process of treating dye effluents.

260,575.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of linings for vessels which are to resist acids.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

CHINOBUT.

479,379.—Chemical substances prepared for use in medicine and pharmacy.—Lamberts (Dalston) Limited, 60 & 62, Queen's Road, Dalston, London, E.8. May 11th.

ADVITA.

478,190.—Chemical substances prepared for use in medicine and pharmacy.—Lever Brothers, Limited, Port Sunlight, Cheshire. May 11th.

476,940.—Illustration of a Polar Bear and the word POLAR, for chemical substances prepared for use in medicine and pharmacy, but not includcod liver oil and not including any goods of a like kind to cod liver oil. —The Star Chemical Co., Limited, 362, Mare Street, Hackney, London E.8. May 11th.

TISO.

470,971.—Chemical substances in Class 1, being products of titanium for use in manufactures; and dyes in Class 1. Anglo American Steel Co., Limited, 66, Victoria Street, London, S.W.1. May 11th.

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A NOTE ON THE FORMATION OF GREEN DEPOSITS IN ANCIENT COINS.

By A. C. CHATERJI, D.Sc.

It has been observed that old silver coins containing a large percentage of copper are coated with deposits which are green or bluish green, while pure copper coins are coloured almost jet black.

The green colour of these adulterated silver coins is mainly due to the formation of basic copper carbonate produced by the action of moist air upon copper which is present in the coins. In certain cases, however, the green deposit may be due to the corrosive action of such chemicals as alkali chlorides which are often present in the earth beneath which the coin might have remained buried for centuries.

In archæological museums, it has been generally observed that ancient bronze antiquities are liable to develop a light green colour. Here also the colour is due to the formation of either of the following compounds :—

Malachite—$CuCO_3.Cu(OH)_2$.
Azurite—2 $CuCO_3.Cu(OH)_2$.
Atacamite—$CuCl_2.3Cu(OH)_2$.

It is, however, interesting to note that unlike coins of bronze, brass, silver-copper alloy, etc., pure copper coins are coated black and are not very readily attacked by the joint action of moist air and carbon dioxide.

The black colour of old coins made of comparatively pure copper may be due to a coating of copper oxide.

According to R. Fink (*Ber.*, 1887, xx., 2106) the affinity of copper for oxygen is greater than that of manganese, zinc, cobalt or nickel : it is even greater than that of magnesium. It is a common experience that copper is soon covered with a black deposit, and special precautions have to be taken to keep the surface of a copper sheet bright. The rapidity with which this coating takes place may be well judged by the fact that a thoroughly cleaned copper piece tarnishes in a few minutes if exposed to moist air. When copper is determined electrolytically, extreme care must be taken to prevent the bright deposit of copper from becoming grey after the experiment is over.

Though copper is rapidly attacked by moist air, the amount of the metal affected is only superficial due to the protective action of the film of oxide produced. The surface is covered with a coating of black oxide and this prevents further action. The inside metal remains unchanged, unless the upper coating is removed.

In the case of a silver coin, however, containing, say, 20 per cent. of copper, the facility with which copper oxide formation takes place will be greatly reduced. According to the Law of Mass Action, the active concentration of copper is very much reduced due to the presence of a large quantity of silver, and hence the quantity of copper oxide produced will be proportionately low.

Moreover, due to the mere presence of a *more* electro-negative metal like silver, copper will be chemically more active and

the carbon dioxide present in the air will easily attack it producing a green basic carbonate.

Due to the above causes a film of oxide is more protective in the case of pure copper metal than in an alloy of it.

It is of interest to note in this connection the recent work of Vernon (*J. C. S.*, 1926, 2273), who has proved experimentally that an oxide film is more protective in the case of metallic copper itself than in those of its alloys.

In other words, pure copper is relatively *less attacked* by chemicals than an alloy of copper with a more electro-negative metal like gold, or platinum, or silver.

Hence, antiquities made of pure copper are relatively less attacked by the carbon dioxide present in air than those made of alloys of copper. This explains the occurrence of green deposits on the latter.

Chemistry Department,
Lucknow University,
Lucknow, India.

May 3, 1927.

A STUDY OF THE MINERAL COMPONENTS OF ORGANISED MATTER.

By Maurice Copisarow, D.Sc.

(*Continued from Last Week.*)

Maassen has shown that the lower vegetable organisms are, like certain animals, able to assimilate telluric and selenic acids with the secretion of a fluid similar to that obtained in the case of arsenic. But as in the case of selenium and tellurium, the substances obtained are not methyl but ethyl-compounds, it follows that in the case of Penicillium Crevicaule the arsenious excretion is, according to Biginelli and Maassen,

diethylarsin : $AsH<\begin{matrix}C_2H_5\\C_2H_5\end{matrix}$. There is no doubt that the number of elements occurring in organisms is not limited to those mentioned in this paper. But it is certain that quantitatively they are far behind those alluded to, which, of course, does not minimise the possibility of their physiological importance as catalysts, ionisers of the fluids, etc. As in the case of animals the detailed analysis reveals the fact that in the vegetable organism, the mineral matter is not uniformly distributed, but is localised and concentrated qualitatively and quantitatively in various organs, according to the special requirements and functions which conclusively proves that mineral matter is not an accidental admixture, but is a regular, essential constituent of organised matter in its functions of life. The difference in the mineral matter of various organs can be seen from the analysis of the seeds, fruits, leaves, trunks, roots, etc. The fruits and seeds having as their function the support of the embryo in its first stage of development, resemble the milk of animals and analysis of the ashes shows the abundance of phosphoric acid, potassium, magnesium, and a comparatively small amount of calcium. Considering the physiological importance of the mineral matter of fruits and seeds, we have not to include the ash of the shells, covers, etc.; but even including them in the data, we see that the percentage of ash is not high, varying between 2 and 4 per cent. So—

	% of Ashes	
Pinus Cembra	1.34	
La ricio	2.71	(Schuppe)
Pinus Silvestris	5.95	(L. Jahul)
Cocos nucifera	0.97	(F. Hammerleache)
Avena sativa (average)	3.32	(Grandeau & Leclerc)
Piper nigrum	1.17	(Weizmann)
Cannabis sativa	5.27	(Wolff)
Agrostemma Githage ...	11.75	(Ulbright)
Spergula arvenis ...	0.27	(Lobe)
Camellia Japonica	1.92	(Kellner)
Hyoscyamus niger ...	2.43	(Wolff)

As to the state of combination of the occuring elements, we find the well-known reactions of the ions K^+, Fe^{++} and Fe^{+++} only after the calcination of the fruits or seeds, which indicates that the potassium and iron exist as complex organic com-

pounds. On the coutrary, the calcium and magnesium give the reactions of Ca^{++}, and Mg^{++}, thus allowing us to conclude that they (also phosphates and sulphuric acids) exist, (partially, of course), in the inorganic form. The percentage composition of the ashes of seers, fruits, etc., can be seen from the following table :—

	K_2O	Na_2	CaO	MgO	Fe_2O_3	P_2O_5	SO_3	SiO_2	Cl
Avena Sativa	27.96	—	7.46	10.12	1.54	47.73	—	—	—
Pisum Sativum ...	43.10	0.98	4.81	7.99	0.83	35.90	—	—	—
Cocos Nucifera ...	43.88	8.39	4.63	9.44	—	16.99	—	—	—
Coix Agrestis	22.04	—	2.63	13.33	4.46	36.82	4.47	—	—
Camelia Japonica	42.62	—	5.01	7.60	9.24	24.74	6.07	—	—
Pinus Cembra	24.16	9.35	17.40	5.13	0.682	32.11	0.98	0.31	—
Piper Nigrum ...	7.15	0.84	31.06	11.64	1.86	30.75	3.76	1.46	0.9
Beta Vulgaris	32.93	4.97	13.44	3.91	3.86	—	0.9	4.19	4.19
Bassia Longifolia	56.68	—	0.64	—	2.01	15.47	6.81	—	—

1, 2 and 3 are analysed by Wolff, 4 and 5 by Kellner, 6 and 7 by Röttger, 8 by Ihlee and 9 by Valenta.

This clearly shows that the amount of Na (not always as a chloride) is as a rule by far smaller than that of K. The percentage of P_2O_5 is throughout a high one, reaching as in the case of Avena Sativa as much as 47.73 per cent. The relative quantity of the organic reserve materials (albumins, fats, carbohydrates) in relation to the total amount of the phosphoric acid seems to be of special significance, as the percentage of P_2O_5 is equally high in tissues, rich in carbohydrates, fats or proteids. Our knowledge of the state of combination of P in the seeds, is relatively more advanced than that of other ash-constituents. The experiments of Schimper, Iwanoff, Schulze, Castaro and Collison have proved that only a small percentage of P is present in the inorganic form as PO_4-ions, while all the rest is present in some complex form. To these belong :—

(1) Glycero-Phosphoric acid, which, as the basis of the lecithins, is of very great physiological importance.

(2) Phospho- and nucleo-proteids, to which we have to add the phosphorus from the phytovitellins. Palladin, Schulze and Winterstein succeeded in isolating from the kernels of Brassica nigra and other vegetables an organic substance, rich in phosphorus, which on digestion with HCl gave inosit, thus resembling, if not identical with anhydro-oxymethylendiphosphoric acid or phytin :—

$$O<\begin{matrix} CH<\begin{matrix} H \\ O.PO(OH)_2 \end{matrix} \\ CH<\begin{matrix} O.PO(OH)_2 \\ H \end{matrix} \end{matrix} = C_2H_8P_2O_9$$

extracted by Posternak (*Compt. rend.*, 1903) which, according to Posternak, gave on boiling with HCl, inosit apparently by the condensation of the CH_2O groups. These complex P-compounds occur usually as calcium and magnesium salts, occasionally as K-compounds. As to the state of combination of sulphur not much is known, but considering that the quantity of S increases with that of the proteids (though several exceptions are known) it is assumed that the S exists combined with the proteins and as Rhondanate. The state of combination of iron and its general significance are unknown, but a small portion of iron was found to be combined with the nucleic acids.

Chlorine varying from minute traces to as much as 2 per cent. does not go parallel with the mass of Na, as can be seen from the following data :—

	% Cl	% Na_2O
Sorghuna Saccharat	0.07	8.35
Beta Vulgaris	10.79	15.58
Daucus Carota	3.75	4.72
Quercus sp.	1.76	0.63
Rubia tinctorum	6.19	6.00

Many other elements are found, especially Al and Mg; Al reaching as much as 0.2 per cent. In connection with the study of seeds we must take the underground food-stores (potatoes, onions, etc.). From the following table we can see that the percentage composition of the ash of the whole plant differs considerably from that of the fruits, seeds, etc. :—

	K_2O,	Na_2O	CaO	MgO	Fe_2O_3	P_2O_5	SO_3	SiO_2	Cl
Solanum tuberosum	60.06	2.96	2.64	4.93	1.10	16.86	6.52	2.04	3.46
Helianthus tuberosum	47.74	10.16	3.28	2.93	3.74	14.00	4.91	10.02	3.87
Daucus Carota	36.92	21.17	11.37	4.38	1.01	12.79	6.45	2.38	4.59
Pastinaca official	54.50	1.51	11.44	5.71	1.12	19.52	5.19	1.61	3.79
Rhaphanus sativus	21.98	3.74	8.78	3.53	1.16	41.12	7.71	8.17	4.9
Lilium tigrinum	53.50	—	1.59	3.23	0.41	10.21	—	—	—
Iris germanica	33.18	—	41.06	3.26	2.71	0.11	8.86	—	—

Manganese similar to arsenic is concentrated in the leaves. (Jadin and Anstruc.) Barium was found to be present in loco-weed (Crawford) tobacco leaves and many other plants (McHargue; Spallino; Artis and Maxwell). The distribution of fluorine (Gautier and Clausman) copper, zinc, nickel and cobalt in the plant world is practically general (McHargue).

We might mention here the work of Stoklasa on the state of combination of iron.

He found that by dissolving the fats of Allium Sepa and acting on it with very dilute hydrochloric acid ,it is possible to isolate an iron-containing compound apparently identical with "Hæmatogen," extracted by Bunge from eggs. In this case, more investigations are required as it is unknown whether this iron-compound is one of the "splitting-off" products of nucleo-proteids or nucleic acids.

In the stem or trunk of a plant, the ash amounts to 2-6 per cent., varying with the age, condition and season, being the highest at the moment of the ripening of the fruits. The leaves are rather rich (comparatively) in mineral matter, having as a maximum as much as 12 per cent. of ash. Potassium varies between 35 and 55 per cent.; sodium between 10 and 40, per cent.; calcium between 1.5 and 65 per cent.; magnesium between .05 and 29 per cent.; iron, so important in the metabolism as combined with chlorophyll, varies between 1 and 4 per cent. P_2O_5—up to 30 per cent.; sulphur as SO_3 reaches about 20 per cent. (Brassica oleracea), the amount of SiO_2 varies greatly from mere traces to as much as 80 per cent. (Larix decidua.)

The following are some of the percentage compositions of the ash of roots :—

	Ash	K_2O	Na_2O	CaO	MgO	Fe_2O_3	P_2O_5	SO_3	SiO_2	Cl
Avena Sativa (in water culture) ...	6.21	22.85	10.67	15.15	7.2	3.12	11.84	7.61	9.15	—
Fagopyrum (in water culture) ...	6.84	17.07	1.44	15.83	3.62	28.98	26.69	1.2	—	6.76
Primula Farinosa...	8.37	2.51	21.1	25.86	4.79	1.24	3.87	2.69	30.16	3.57

Although we could continue the quoting of data for the percentage of the ash and its composition for various groups of plants as well as for the different parts of a particular vegetable, it is thought the previous data are quite sufficient to illustrate the universal distribution of mineral matter and its variation quantitatively as well as qualitatively in accordance with the environment and special requirements of every plant or even more of every cell of any organism. So far as our knowledge goes, no living organism, no cell, has ever been found to be free from mineral matter, in fact, life, the harmony of unity, is based on variety. Metallo-organic salts, capable of being ionised, catalysts, enzymes, all forces and phenomena, known to us from the outside world, in their union, from that which is known to us as an organism, a perfect small world of its own, full of life or evolution. In comparing the mineral matter of animals with that of vegetables, we find that the difference is rather a quantitative than a qualitative one, the difference in the state of combination is subject to the physiological and bio-chemical requirements or tendencies.

Recognising mineral matter as a normal constituent and important factor in all metabolic changes, we must in the study of diet, give it a place equal to that of carbohydrates, fats, proteins, and vitamines.

The mineral world, flora and fauna (referred to at the beginning of the paper, in the form of a diagram), may be represented as *circles* coming in contact with each other at continuously varying points.

General Notes.

HISTORY OF COBALT IN CANADA.

The cobalt district lies in a rugged region of the Pre-Cambrian Shield about 330 miles due north of Toronto, and midway between Lake Ontaria and Hudson Bay. Rich ores were first discovered in the district in 1903, as the result of the construction of the Timiskaming and Northern Ontario Railway northward from North Bay. To indicate how valuable deposits may readily escape observation in rough country, the following facts may be cited : These ore-bodies were near an old and well-travelled canoe route; an argentiferous galena deposit had been worked over 150 years before on Lake Timitkaming, eight or nine miles to the eastward; and the history of silver mining in Canada commenced with the discovery of a deposit of similar character on the east, or Quebec side, of Lake Timiskaming in 1686.

The rocks in the vicinity of Cobalt are Pre-Cambrian. At the base of the Geologic Column is a highly altered volcanic complex, the Keewatin. This is stratigraphically overlain by the Cobalt series of sediments including a tillite, and these rocks are intruded by dykes and sills of diabase, believed to be of about the same period as the nickel-bearing irruptive of Sudbury. All of these rocks are now dense and hard.

The ore-bearing fissures are true rock fractures or faults of slight displacement. Most of the numerous veins are a fraction of an inch in width. They are generally straight and quite barren of metallic minerals for considerable distances, and may pass into as eries of parallel fractures, one of which may carry ore. In the case of important ore-shoots, they then pass into remarkably well defined veins of 3 or 4 to 8 inches in width, carrying a solid mass of cobalt and nickel arsenides more or less impregnated with native silver and with a rather subordinate amount of gangue, mostly calcite, with which a little quartz is occasionally associated. In some of the veins there is clear evidence of two periods of fracturing and of mineral deposition. For example, on polished surfaces silver may be observed following minute cracks

In 1913, 115 productive veins were known in the Cobalt area, occurring in rocks representative of all the age divisions recognised.

Silver ores of the same kind have been found in similar geological relations elsewhere in the general region around Cobalt, Of these the most productive are the South Lorrain field, 18 miles south-east of Cobalt, and Gowganda, 60 miles west of Cobalt. Four mines were producing in each of these fields in 1925, at which time there were eighteen at Cobalt.

After 1905, when the output of silver across both the cobalt ore and gangue. from these camps was 2,000,000 ounces, production increased rapidly until a peak, reported as 30,500,000 ounces, was reached in 1911. It dropped to 29,000,000 in the next year, and followed a downward trend until 1921 when less than 10,000,000 ounces was produced. There was little change in the output in the next four years. The Nipissing mine was the principal producer and other large mines in order of production were Keeley, Frontier Lorrain, Castle Tretheway, Mining Corporation, O'Brien, Lorrain, Trout Lake and McKinley-Darragh-Savage.

For the past twenty years the Cobalt silver area of Canada has been the main source of the world's supply of Cobalt. In the period 1907-1926, both years included, the total output was 21,843,764 pounds. The ore shipped from the Cobalt area between 1905 and the latter part of 1907 was sorted by hand or with crude mechanical appliances. Since then extensive concentrating plants have been erected.

A NEW SPECIFIC COLOUR REACTION FOR MAGNESIUM.

By I. M. Kolthoff (Holland).

"Titan yellow" is found to be a very sensitive and specific reagent for the detection of magnesium. The procedure is as follows :— To 10 c.c. of the solution to be tested, .2 c.c. of a .1 per cent. solution of the indicator and .25 to .5 c.c. of four times normal sodium hydroxide solution are added. In the presence of magnesium the yellow colour changes to red. The test is sensitive down to solutions of .2 mg. per litre. Calcium salts when present intensify the red colouration.

The reaction is very suitable for the detection and colorimetric determination of traces of magnesium in tap water, etc. The best colour scale is obtained with solutions containing 4 to .4 mg. of magnesium per litre. If the solution to be examined contains calcium the colour standards are prepared in solutions containing about 100 mg. of calcium per litre.

Aluminium and tin interfere with the test and must be removed before it is applied. The influence of zinc can be eliminated by the addition of excess of sodium sulphide solution, filtration is unnecessary. (*Abstracted from "Chemisch Weekblad,"* 1927, xxiv., 254.)

CAMBRIDGE UNIVERSITY NEWS.

On May 20, at a congregation of the Regent House, the Vice-Chancellor (the Rev. G. A. Weekes, Master of Sidney Sussex) presiding the bequest by Professor A. W. Scott, of Lampeter to the University, of £70,000 for the furtherance of Physical Science, and one-third of the residue of his estate for a similar object, was gratefully accepted.

Professor Houseman was appointed to represent the University at the Centenary of University College, London, on June 23.

Mr. E. E. Raven, of St. John's, was appointed a Pro-Proctor for the ensuing academical year.

Mr. D. Portwag, of St. Catherines, was re-appointed a Special Pro-Proctor from October 1, 1927, to September 30, 1929, to deal with the regulation of the use of motor vehicles by members of the University *in statu pupillari.*

On the nomination of the General Board, Dr. T. R. Elliott was appointed an elector to the Professorship of Physiology until February 20, 1933, in the room of the late Dr. E. H. Starling.

The recommendations made in the report of the Council of the Senate dated April 25 last, on the admission of women to University instruction, was approved.

The Local Examinations Syndicate was authorised to contribute the sum of £500 in the current financial year towards the cost of improvements being carried out at Fitzwilliam House by the Non-Collegiate Students' Board.

Subsequently at a Congregation of the Senate, the following Degrees were conferred :—

M.A. (Graces 8 of February 18 and 21 of May 7, 1927).—Thomas Callan Hodson (Reader in Ethnology), who was presented by the Public Orator.

M.A.—By Proxy.—P. J. Sykes (King's), M. A. van Hulsteyn (Trin. H.), J. F. M. Taylor (Queen's), P. Sands (Non-Coll.). In Person.—The Hon. C. B. Buckley, R. W. H. Couzens, K. E. N. S. Lamplugh, and G. H. W. Rylands (King's), A. M. Brown and G. S. Hall (Trin.), W. H. Charnock, A. M. Ewbank, and R. B. Lloyd (Joh.), D. R. Grigg (Pet.), A. N. Carruthers (Cla.), R. W. O'G Davis and W. P. Ford (Pemb.), E. A. Barclay-Smith, G. H. Goldsmith, L. H. J. Hersch, J. M. Kirby, G. H. Taylor and K. H. Uttley (Gonv. and Cai.), C. W. F. Lydall and I. S. Watkins (Trin. H.), W. G. Butler and C. S. Deakin (Queens'), F. W. Bracecamp, W. J. Dyer, and E. J. M. Wyld (Jes.), L. H. Downs (Christ's), W. D. N. Hoare and L. B. Prince (Magd.), H. Bailey, A. K. Bird N. B. C. Lucas, and R. G. Martin (Emm.), L. J. Stanford and E. N. J. Walker (Sid. Suss.), C. Jenkinson (Non-Coll.).

B.M. (In Person).—The Hon. C. B. Buckley (King's).

OVERSEAS TRADE IN APRIL.

Allowing three days for the Easter holidays, the working time in April was about 15 per cent. less than in March, and taking this into consideration, and assuming no change in prices, imports per working day in April showed a rise of about 4 per cent. and exports of imported produce an expansion of about 29 per cent., while exports of British produce and manufactures showed a reduction of about one-half of 1 per cent. If the April figures are compared with the average of the preceding three months there was a reduction in value of 6 per cent. in imports, a reduction of about 7 per cent. in British exports, and an increase of nearly 13 per cent. in re-exports; the reductions are well within what might have been expected from the loss of time in April. Finally, if we compare the trade of last month with that of April, 1926, which also included the Easter period, there was a reduction of less than 2 per cent. in the money values of imports and of less than 1 per cent. in British exports, while re-exports increased by about 5 per cent. As there has been a fall in values per unit in the interval, and there is little doubt that a year ago there was some extra pressure to clear goods in anticipation of the General Strike, it is safe to conclude that the volume of trade in April, 1927, was greater than it was a year ago.

CONTINUED ECONOMIC IMPROVEMENT IN SWEDEN

Last year exhibited many encouraging features, such as comparative freedom from labour disputes, a good harvest, a slight but steady increase in industrial production, a gradual fall in commodity prices and the cost of living, enhanced foreign trade and

an improvement in its balance, including increases in exports of staple manufactures, such as pulp, paper, machines; higher shipping freight rates and the resultant expansion of orders to the shipyards; further consolidation in the position of the banks and the larger industrial enterprises; and a decrease in the number of bankruptcies—all reflected in a general improvement and easy conditions in the money market; in fact, the most unsatisfactory feature appears to be the gradual increase in unemployment, which is attributed in part to the continued precarious position of a section of the iron industry. A feeling of restrained optimism has characterised the beginning of 1927, and it is anticipated that Sweden will benefit also by the progress being made in the political and economic stabilisation of Europe.

CANADA'S GYPSUM PRODUCTION, 1926.

Continuing the advance in gypsum production recorded in 1925, the shipments during 1926 created a new high mark for the industry in Canada. Increases in tonnages shipped were reported in all producing provinces except New Brunswick. The total production for the year amounted to 878,283 tons worth $2,761,937 as compared with 740,323 tons at $2,389,891 produced in 1925. The average values received by the operators were as follows : lump, $1.49; crushed, $1.73; fine ground, $6.13; and calcined, $10.07 per ton.

Importations of gypsum, all grades, into Canada were recorded at 6,298 tons worth $119,141 as against 8,921 tons with a valuation of $136,308 imported in 1925.

SELECTIVE FLOTATION FOR CANADIAN ORES.

The Mines Branch of the Dominion Department of Mines at Ottawa has just issued Memorandum No. 29, dated March, 1927, dealing with " Selective Flotation as Applied to Canadian Ores." The Memorandum, which is by Mr. C. S. Parsons, Engineer, Division of Ore Dressing and Metallurgy, recalls that Canada possesses many deposits of complex ores such as lead-zinc-iron sulphides, copper-zinc-iron sulphides, copper-iron sulphides, and other combinations of these minerals, many of which contain values in both gold and silver.

The Mines Branch of the Department of Mines, through its Ore Dressing and Metallurgical Laboratories at Ottawa, has made numerous investigations into the treatment of such Canadian ores by selective flotation. The purpose of this review is to bring more directly to the attention of the mining public the information which has been acquired and the progress which has been made in the treatment of ores by this method, and also to point out the assistance the Government is rendering the mining industry by maintaining at Ottawa fully equipped ore dressig and metallurgical laboratories for research on the treatment of ores and metallurgical products. A brief description of the flotation equipment of these laboratories is given in order that the reader may better realise the type of work which can be performed.

Copies of the Memorandum will be available shortly for distribution by the Natural Resources and Industrial Information Branch, The Canadian Building, Trafalgar Square, London, S.W.1.

COPPER IN CANADA.

A preliminary estimate of the total copper production of the world in 1926 is 1,658,000 tons of which amount Canada probably contributed about 70,000 tons, or 5 per cent., compared with 54 per cent. for the chief producer, the United States. A little more than two-thirds of the total Canadian output comes from British Columbia; most of the remainder from the nickel-copper mines at Sudbury, Ontario, and there is a small production from the Eastern townships in southern Quebec.

Practically all the British Columbia copper is derived from three large mines, operating on immense low-grade deposits of disseminated copper sulphides to which a small additional value is given by accompanying gold and silver.

GASOLINE FROM LIGNITE.

A French scientist has invented a process for distilling gasoline from lignite (says *Popular Science Monthly*, New York). The yearly supply is expected to be a quarter of a billion gallons from twenty million tons of lignite, and there is sufficient lignite in France to last a century and a half.

SAFEGUARDING OF KEY INDUSTRIES.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding the following articles :—

Didial (Ethyl morphine diallyl barbiturate).

Ethylene glycol.

Glycol ethers.

Section 10 (5) of the Finance Act, 1926, is as follows :—

" The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any person desiring to communicate with the Board of Trade with respect to the above-mentioned application should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street ,S.W.1., within two months from the date of this notice.

CHORZOW NITROGEN FIXATION FACTORY.

The claim of the German Government against Poland in connection with the Chorzow Nitrogen Fixation Works has been decided by the International Court of Justice. Its findings are that the Polish Government should pay 75,000,000 marks in compensation.

THE " ALKALI " SOIL PROBLEM.

By Eric S. West, M.Sc.

(Abstracted from the *International Review of the Science and Practice of Agriculture*, March, 1927.)

The old problem is restated and advice given.

The term " Alkali " is a misnomer as the salts concerned are never true alkalis.

Their effect in the soil is either toxic, or, by their concentration in the soil they may induce osmosis, with a consequent drooping of plant life. In order of toxicity, the salts most usually encountered are sodium carbonate, sodium bi-carbonate, magnesium sulphate, sodium chloride, calcium chloride, sodium sulphate and calcium sulphate. The above salts however, though toxic alone, often lose their toxicity in the presence of a second salt equally toxic alone and equally harmless in the presence of the first.

Origin of " Alkali " Soils.

(1) Change in geological formation leading up to drying up of lakes; (2) Repeated irrigation with water containing salts; (3) Concentration of salts already present into one layer by percolation of irrigation water downwards and the upward movement due to capillarity.

Preventive Measures and Reclamation.

1. Proper drainage; 2, purification of irrigation water by dams, etc; 3, reduction of surface evaporation by mulching; 4, removal of salts by flooding in presence of adequate drains; 5, application of gypsum, farmyard manure, etc.; 6, use of salt resisting crops such as the *Chenopodaceae*; 7, after heavy irrigation or deep ploughing planting such crops as lucerne which, very susceptible to salinity as a seedling, is very tolerant when mature, and has the effect of shading the soil and of absorbing a great deal of water by its deeply penetrating roots, so checking capillary action.

BACTERIAL ACTIVITY IN SOIL DURING THE DRY SEASON.

By E. Bigini.

(Abstracted from the *International Review of the Science and Practice of Agriculture*, March, 1927.)

The production of carbonic acid has been examined in order to gain an approximate idea of the total activity of microflora, *i.e.*, of the sum total of the respiratory activities of all categories of organisms living in the soil. All investigators agree in concluding that the seasonal variations of microbial activities in the soil depend essentially on humidity even more than on temperature. At the same time it is known that the drying up of the soil encourages such microbial activity as nitrification, fermentation of carbohydrates, putrefaction.

The experiments of the author show that :—

Generally speaking, microbial activity, judged by CO_2 production, ceased entirely on the surface of the soil during the hottest and dryest months when soil humidity fell to zero (not taking into account hygroscopic humidity).

The addition of water, without organic matter, did not lead to an appreciable increase in the production of carbonic acid, whereas adding organic matter notably increased CO_2 production even in soil having a humidity of less than 4.6 per cent.

Green manure helped to maintain the soil aptitude for fermentation processes and for this purpose the presence of organic matter is more effective than humidity. Green manure raised and preserved bacterial activity in proportion to its protein content (vetch more than beans).

Sub-irrigation, even if repeated at lengthy intervals, was responsible for a greater microbial activity.

Ammonification (aerobic putrifaction) of organic nitrogen took place also in acid surface layers when the author added organic nitrogenous substances, such as scraps of horn and hoof, vetch, hay and manure.

There was a higher nitrification in nearly dry ground than in damp. In soils treated with green manure, however, or in those taken from irrigated areas, nitrification increased.

In soil of dry surface layers there was no nitrogen fixation. In other soil, especially that treated with green manure or sub-irrigated, the fixation was considerable.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY.

The following papers were read on May 9, 1927 :—

Note on a Connection Between the Visible and Ultra-Violet Bands of Hydrogen. By O. W. Richardson, F.R.S.

It is shown that there is evidence in the visible secondary hydrogen spectrum of the existence of bands whose final states are the same as the initial states of the bands found by Werner in the Lyman region. Some of the consequences of this are discussed including a recalculation of the moment of inertia of the normal hydrogen molecule. The value found is 4.5×10^{-41} gm. cm.^{2}.

Homogeneous Reactions Involving Complex Molecules.—The Kinetics of the Decomposition of Gaseous Dimethyl Ether. By C. N. Hinshelwood and P. J. Askey. Communicated by H. Hartley, F.R.S.

The decomposition of dimethyl ether takes place according to the equation $CH_3 . O . CH_3 \rightarrow CH_4 + HCHO \rightarrow CH_4 + CO + H_2$, the formation of formaldehyde being but transitory.

The reaction is especially unimolecular at pressures above about 400 mms., but at lower pressures ceases to be independent of the initial pressure. The pressure of sufficient hydrogen keeps the reaction unimolecular at all pressures. The hydrogen seems to act only by maintaining the Maxwell distribution among the molecules of ether, when this would otherwise be disturbed by the chemical transformation of activated molecules; for it can only restore the rate of reaction to its normal limiting value and cannot increase it beyond this. Nitrogen, helium, carbon monoxide and carbon dioxide do not have a similar influence.

The limiting rate is expressed by the equation : —

$$\ln k = 30.36 - \frac{58.500}{RT}$$

About 11 energy terms are needed to account for the observed rate if activation is by collision.

An Experimental Test of the Dipole Theory of Adsorption. By W. G. Palmer. Communicated by Sir William Pope, F.R.S.

The electric coherer functions normally when the loose contact is immersed in liquids, and the cohering voltage increases regularly in the homologous series of primary alcohols, fatty acids and their ethyl esters, according to the rule E^2/l = constant, where l is the length of the chain. This experimental result indicates that the energy of desorption in a given series is proportional to the square of the electric moment of the adsorbed molecule, and its strongly supports the dipole theory of adsorption. An attempt to extend the theory to include the adsorption of substances that are normally " non-polar " is supported by further experiments on the adsorption of hydrocarbons.

Thermal Changes in Iron-Manganese Alloys Low in Carbon. By Sir Robert Hadfield, F.R.S.

In this paper are presented the heating and cooling curves of the alloys of iron and manganese, of which the physical and mechanical properties have already been described.

The temperature at which evolutions or absorptions of heat of a critical character

occur during heating and cooling are shown by curves of the "inverse rate" type; magnetic changes are indicated in separate curves, determined by a magnetic induction method.

It is shown that the temperature at which the final recovery of magnetism occurs on cooling, with its accompanying evolutions of heat, is progressively lowered with increasing manganese percentage.

The transformation, however, becomes gradually weaker in intensity and finally vanishes while, still at a temperature of about 100° C., and at a manganese percentage just short of that at which non-magnetic qualities are reached, namely 16 per cent.

Thus the explanation that the alloys exceeded this percentage owe their non-magnetic qualities to their critical change points being below atmospheric temperature, is not tenable. Alternatively, it is suggested that the present research gives further support to the belief that the suppression of the magnetic qualities of the iron may be due to its actual combination with the manganese.

FARADAY SOCIETY.

The following paper was read at the meeting held on October 1, 1926:—

General Discussion on Physical Phenomena With Special Reference to Molecular Orientation. By ERIC K. RIDEAL, Lecturer of Physical Chemistry, Cambridge.

ABSTRACT.

The necessity for a detailed study of physical phenomena at interfaces is now recognised as of urgent importance to science. There appears to be a real danger that colloid chemistry, especially in its biochemical and physiological aspects, may sink into disrepute beneath the waves of a sea of nomenclature which conveys nothing to the mind of the average scientific reader .

There are four types of interface concerning which a good deal of general and some particular information is avialable, namely the liquid/gas and liquid and the solid/gas and liquid interfaces.

A study of the two former possesses certain advantages over that of the latter in that they are more simple, for the reason that the free surface of a liquid is a surface of equipotential. We must note that with the possible exception of specific crystal facets in homopolar crystal solid surfaces are not uniform either in texture or surface energy.

The study of the physics of the liquid interfaces has proceeded along two distinct paths which, in the case of solutions of non-electrolytes at least, have been shown to lead to identical results. In the case of insoluble films on a liquid surface the evidence for a two-dimensional unimolecular phase capable of existing in the solid, two liquid, the condensed and expanded, vapourous, gaseous and allotropic solid states has been amply confirmed and extended in a variety of ways.

The conditions of equilibrium of these insoluble films with crystals or lenses of materials from which they are formed have also been studied and shown to conform to the generalisations embraced under the phase rule. There are, however, certain points on which more information is required. Why is it, for example, that, on immersion of a rod of a solid acid such as myristic acid beneath the surface of water, solution only occurs in a ring which appears to be not much larger than that formed by the air/solid/liquid interface? Again, what is the condition of equilibrium of a lens of a liquid acid floating on the surface of a liquid and in equilibrium with its unimolecular two-dimensional surface fium?

We might also inquire why a layer of solid palmitic acid but one molecule thick melts at the same temperature as the bulk solid. The rigidity of these single films and the magnitude of their elastic constants are such as to indicate that the crystal must be extremely loosely held between the alternating layers at which the hydrocarbon tails are adhering to one another.

The bridge between those insoluble films for which the surface concentration is susceptible to direct measurement and those films for which the surface concentration can only be calculated by means of the thermodynamic equation of Gibbs and J. J. Thomson,

$$\Gamma = -\frac{d\sigma}{du}$$

has recently been completed by Frumkin. For this reason we are on more certain ground than we were a few years ago for the hypothesis, dating from the time of Traube and Milner, that the Gibbs' films of solutions were unimolecular in thickness. The thermodynamic method itself, of course, gives us no information on this point. A further confirmation of the view that some Gibbs' films are at any rate unimolecular in character is derived from an

examination of the original hypothesis of Traube, in respect of the surface of solutions of capillary active and soluble substances, such as the lower fatty acids, that they constituted gaesous films. It has been shown by Schofield and myself that over relatively wide ranges of concentration they conform to the equation of Amagat and thus represent two-dimensional gases under high pressure.

The unimolecular character of all Gibbs' films for such non-electrolytes cannot however be regarded as proven, for at high concentrations of such substances as ethyl alcohol and acetic acid the surface concentration calculated by the Gibbs' equation falls. If we still wish to maintain the conception of a fairly tightly packed layer of alcohol molecules on the surface, we must alter the position of our arbitrarily chosen dividing line so as to include more water, not only underneath the top layer, but also in the Gibbs' firm. It seems difficult to avoid the conclusion that the range of the surface forces is such as to be capable, under certain circumstances at least, of offecting the bulk concentration, in spite of osmotic readjustment to layers more than *one* molecule deep.

There is another problem similar to this which it may be convenient to mention at this point. From the experiments of Hardy, which have been most exhaustively extended by Harkins and his pupils, we have fairly conclusive evidence that " polar " groups inserted in hydrocarbons actually combine with water with a definite loss in free energy. Whether this combination is stoichiometric or atmospheric or again limited, in the sense employed in Werner co-ordination compounds by considerations of size, is at present unknown, but some form of union would appear to be essential. We must inquire in what manner a molecule of fatty acid on the surface of water undergoes its two-dimensional thermal agitation. It is clear that it must move either with a considerable amount of substrate attached to it or perform a most complex series of chemical reactions in order to move at all. In either case the composition of the substrate must have a very considerable influence on its mobility. In the case of phenol solutions in salt water it would appear that alteration of the salt concentration does not affect the surface concentration of phenol for identical bulk activities, but does alter the effective thermal agitation to which the surface tension lowering is due.

It may not be too much to hope that the surface mobilities of molecules and of ions may be determined in the future.

As has already been indicated, the Gibbs' film of solutions appears to lose its unimolecular character in strong solutions, *i.e.*, when the internal pressure of the "solvent" changes and we have seen that from the kinetic view also we must regard part of the substrate as an integral part of the film. These considerations appear to become increasingly important near the point at which a new bulk phase makes its appearance; two such cases may be mentioned, viz., the case of phenol solutions near the salting-out point, studied by Goard, and that of mercury in contact with methyl acetate vapour in the neighbourhood of its critical pressure, investigated by Iredale. Here it would appear that the transition between a unimolecular adsorbed film and a layer of such a thickness as to possess the properties of a surface of the substance in bulk, is not abrupt, but that there exists a transition state, characterised by instability, in which the film thickens, each molecular layer added resulting in a small but definite decrease in free energy.

Attempts have not been lacking to prove that the surface of a pure liquid consists of molecules more or less partly orientated. The variations in the Eotvos " constant " indicate that some slight degree of orientation must exist, but this appears to be low on account of thermal agitation. Provided that the life time of a molecule on the surface of a liquid exceeds 10^{-7} sec., *i.e.*, a temperature which can readily be calculated from a knowledge of the critical constants, there is ample time for a molecule to orientate itself, so as to take up a position of minimum energy, but such orientation is readily disturbed by thermal agitation; thus at a temperature of 0.7 T_c one molecule in twelve of ethyl alcohol possess sufficient energy to break away from any such directive force; for chlorobenzene orientation is more complete as only some 2 per cent. of the surface molecules are sufficiently active.

In concluding this section on liquid interfaces I might mention briefly a rather interesting branch of the subject, namely interfacial electrification. Whilst there undoubtedly exists a potential difference at an air liquid interface its measurement in absolute units has not yet been achieved. The alteration in potential caused by the replacement of the liquid surface by a Gibbs' layer of known composition can,

however, readily be ascertained, a problem first attempted by Donnan and Kenrick and more recently extended by Frumkin and Guyot. Whilst this alteration in the electromotive force is in reality caused by the replacement of a free and possibly partly orientated water surface possessing an electric moment by one containing orientated solute molecules, it is interesting to calculate the apparent change of electric moment caused by such replacement by the solute molecule. We find that, when this operation is performed, the change in electric moment in hydrocarbons containing polar groups appears to be due almost entirely to the group; thus for the group—COOH $\omega = 0.3\,10^{-18}$. Such electric doublets should, of course, repel one another at close distances. If the molecules are imagined as being separated by water of dielectric constant 80, the repulsive force is extremely small, and it would require a value of the Specific Inductive Capacity of some 6-8 to give a repulsion of the correct order of magnitude. In the case of electrolytes, also, at mercury-water interfaces a similar low Specific Inductive Capacity is required. It is worth enquiry whether, in thin films, liquids possess different values for the Specific Inductive Capacity than they do in the bulk; the indirect evidence certainly supports this view. One of the most interesting points resulting from these calculations is the fact that the electric moment of replacement of water by a definite polar group appears to be constant in a series of compounds; an extension of the method to complex and especially cyclic organic compounds may throw some light on the vexed question of polarity.

Not only can solute molecules alter the interfacial potential difference by replacement of orientated solvent by orientated solute molecules, but ions can effect similar results. The electric double layer of Helmholtz and the diffuse double layer of Gouy must be replaced to satisfy the experimental data by a composite double layer, of a type originally suggested by Stern, consisting of one of the Helmholt type and, outside this, a diffuse one. There is some evidence that the interfacial Nernst potential difference can be divided into two parts, that across the condensed double layer and the electrokinetic potential of Freundlich across the diffuse layer. These are not necessarily of the same sign. The condensed double layer rapidly increases as the polarisation is increased and it is interesting to note that for the condensed double layer the lateral electrostatic repulsion giving a surface tension lowering is similar to that obtaining for electric doublets, *i.e.*, a variation according to the inverse fourth power law. We note, also, in this transition from adsorption of polar molecules to adsorption of ions that the purely electrical effects increase in magnitude, as is to be anticipated from the increasing value of the electric moment, but, even, in the extreme cases of completely dissociated electrolytes, the chemical " adhesion " is one of the most important factors, giving rise to the anomalous lyitropic series in precipitation of colloids by ions and to the marked departures from the Hardy-Schulz law of electrovalent precipitation.

I might emphasise the point that the applications of the thermodynamic treatment of Gibbs to the case of adsorption of, say, a mercurous salt at a mercury-water interface yields results in agreement with experiment; there is no need to distinguish between capillary and electro-capillary adsorption. Again, the views of Lippman, Helmholtz and Nernst on the origin of the potential difference at such an interface are equally readily interpreted on the simple basis of Gibbs' equation.

The solid/gas and solid/liquid interfaces are important in that a large part of colloid chemistry, as well as the subjects of heterogeneous and catalytic contact actions are intimately connected with the properties of such solid surfaces.

A study both of the adsorption isotherms as well as the catalytic activity of solid surfaces reveals the fact that neither in adsorbing power nor in catalytic activity is the surface of a solid uniform. Again, from the work of Born and Jones on the surface energy of heteropolar crystals, we note that the surface energies of different crystal facets, edges and corners are markedly different, whilst we are aware of definite breaks in the adsorption isotherms of substances (first noted by Gustaver for picric acid on charcoal), of patches of varying catalytic activity (noted by us at Cambridge, by Taylor and Benton, at Princeton, Vavon and Husson and Kubota and Yoshikawa), of patches of varying free energies as measured by the heat evolution on absorption (noted by Garner for oxygen on charcoal and by Taylor for hydrogen on copper), of patches on sodium with different thermionic work functions (noted by Richardson and Young). We know, however, little about the dependence of these various factors on the texture of the sur-

face. We do know, however, that in certain cases the surfaces which are most active catalytically are not those which are mostly strongly adsorbing for all substances, also that the surface of one material, *e.g.*, thoria, may be prepared so as to promote two different kinds of decompositions of substances such as ethyl alcohol. It seems difficult to avoid the conclusion that a particular spacial disposition of several atoms on the surface is required for a specific catalytic action, this configuration being associated with some type of field which holds the adsorbed reacting molecule in some particular distorted configuration, neither field strength, as determined by the adsorbing power, nor configuration alone being sufficient to define a catalytically active patch.

We may also note that such poisoning as is necessary to reduce the catalytic activity of a metallic surface is also effective in stopping the thermionic emission. Although thermions appear to perform some function in propagating or commencing homogeneous reactions at some distance away from the catalytic surface, yet the identification by Richardson and Young of patches of low threshold values for the thermionic emission may not be without significance. The conception of an active patch in which a number ,possibly a small number, of atoms are so arranged that, on adsorption of reactants, the complex formed by adsorbate and adsorbent has a particular configuration, is one which is not without value in interpreting the curiously selective actions of the enzymes in promoting catalytic action ,of the reactions between toxin and antitoxins and, in the sensitisation by proteins, especially the euglobins, of certain suspensions to electrolytes, the basis of the Wassermann and the precipitin tests. On these organic surfaces the active points appear to be acidic and basic groups which are " spaced " by being incorporated in chain or ring of a complex molecule. At the same time it must not be forgotten that in these systems the dispersion is frequently great, with the result that the curvature of the free surface becomes an important factor which cannot be left out of consideration, for the Gibbs' equation in its simple form is only applicable to plane surfaces.

Whilst during the last decade a very considerable advance has been made in our study of the molecular structure of these interfacial phases, yielding results which can be tested by the application of the thermodynamic method, yet it is clear that in many directions we have done little more than scratch the surface of this fertile field.

THE OPTICAL SOCIETY.

At a well attended meeting of the Optical Society, held at the Imperial College of Science and Technology ,on Thursday, May 12, the following paper was presented :—

Contributions to the History of English Opticians in the First Half of the 18th Century (with Special Reference to Spectacle History). By PROFESSOR MORITZ VON ROHR, Ph.D., Hon.M.D.

ABSTRACT.

Although London opticians during the 18th century had carried out really splendid work as craftsmen, they were not very quick at adopting new ideas. This was a great drawback, especially as about 1818 Fraunhofer succeeded in raising the standard of his factory to quite an unrivalled height. Although Fraunhofer's innovations do not seem to have had any direct influence on English opticians, they were acknowledged by English scientists. Strenuous endeavours were made between 1826 and 1829 by Sir John Herschel and Michael Faraday to produce optical glass, and splendid theoretical work was carried out by Aairy, Coddington and Hamilton. London opticians, however, did not derive the same amount of help from such scientific innovations as the Vienna school did from Stampfer and Prechtl, who were then professors at the Vienna Polytechnic Institute. There it was possible, from 1826 onwards, to raise the standard of the best craftsmen to a very respectable height—nearly to that of the Benedictbeurn-Munich craftsmen—and the good fortune of securing Petaval's help gave, in 1840, the leading position in the manufacture of photographic lenses of high aperture to the Viennese firm of Voigtländer. The great inventions of stereoscopy and photography presented opticians with quite new problems, and English amateurs were the first to understand photographs as perspectives of the depicted object. At the end of the period discussed in this paper a well directed optical glass factory was established in England.

COAL SAVING IN FRENCH STATE TOBACCO FACTORIES.

By A Well-Known Engineer.

More scientific methods in connection with the efficient utilisation of all kinds of refuse and difficult material for steam and power generation is now occupying more and more the attention of steam users in many different countries of the world. A recent example of the value of this general principle is the result of some very interesting tests that have been carried out at the French Government Tobacco factory of the Etat de Paris-Reuilly, using coke breeze and coke dust from gas works.

At this particular factory the boiler is of the " Delaunay-Belleville " water tube type, and in order to reduce the coal bill and avoid the use of expensive coal by burning available small coke, a particularly difficult fuel, there was fitted the " Turbine " forced draught steam jet furnace.

The plant works at a pressure of 15 kilograms per square centimetre (213 lbs. per square inch), and during a typical trial of 10 hours the amount of coke dust consumed was 1,620 kilograms (3,561 lbs.), while the water evaporated worked out at 7,160 kilograms (15,752 lbs.), that is equal to 4.42 lbs of water per lb. of coke dust. It should be emphasised that on this installation no feed-water economisers at all are being used, while the water is cold, the exact temperature during the trial being 17° C. (62° F.), while coke breeze dust, as usual, is an extremely poor fuel from the thermal point of view, averaging 21.6 per cent of ash, with 12 per cent. moisture, in addition to the usual difficulties of low chemical reactivity.

As a result very great economy has been effected, and there is the possibility that the same methods will be adopted throughout the whole of the many different factories owned by the State Control of Tobacco all over France, while considerable progress is now being made, especially in Canada and Australia with the use of raw lignite on these lines.

NOTICES OF BOOKS.

Standards Yearbook, 1927. U.S.A.

The Standards Yearbook represents an effort to present an adequate picture of the diversification and ramification of the standardisation movement which has spread throughout the world with astonishing vitality during the 25 years that have elapsed since the establishment of the National Bureau of Standards. It contains outlines of the activities and accomplishments of not only this bureau and other agencies of the Federal Government and the states and municipalities, but also of the American societies and associations of which standardisation is a major or very important activity. Descriptions and illustrations are presented of all the fundamental national standards of the United States. Moreover, outlines are given of the various foreign national and the several international standardising agencies.

To manufacturers, industrial experts, engineers and purchasing agents both governmental and general, to all officers and agencies concerned with standardisation, the Standards Yearbook will be most valuable. It will inform the manufacturer of the current standardisation movements affecting his industry. It will inform purchasing agents of new standard specifications, being supplementary to the National Directory of Commodity Specifications in this respect, and will inform the scientist engaged in research as to current research projects which may lead to standardisation. To the average reader it will prove a mine of information on the present status and trend of standardisation in all fields of industry, commerce, science, and Government, with references to sources of further information.

The Standards Yearbook is being issued as Bureau of Standards Miscellaneous Publications No. 77, and can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at $1 per copy.

THE SIMPLICITY OF MODERN PHOTOGRAPHY.

Many a camera user, even though he be full of enthusiasm, works with the fear of failure. In the majority of such cases it is a faulty realisation of the nature of photography that produces useless negatives and feeble disappointing prints. The truth is that photography, although truly an art, has been built up on a scientific foundation, and, for this reason, is continually evolving. As a rule, the unsuccessful photographer is one who refuses to take advantage of the enlightenment brought about by scientific research and improve his methods accordingly.

If any photographer needs to be convinced of the importance of the influence of science on practical photography, he should get a copy of an attractive booklet that has

just come into our hands. The title, "Scientific Simplicity in Photography," will appeal to all thoughtful photographers, and the contents of the booklet can certainly be commended to camera users of all grades of skill and experience.

Although so full of information, this book will be sent, post free, to any reader mentioning the *Chemical News*, and applying to Burroughs Wellcome & Co., Snow Hill Buildings, London, E.C.1.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Friday, June 10, at 9 p.m.—"The Excavations at Ur." By C. Leonard Woolley.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

12,809.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of vat dyestuffs. May 14th.

12,544.—Doctor, C.—Yeast tablets, and manufacture thereof.

12,783.—Fairlie, J., and Fairlie & Co., Ltd., H.O.—Manufacture of chromates of potash.

12,808.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of derivatives, etc., of anthraquinone. May 12th.

12,668.—I. G. Farbenindustrie Akt-.Ges. —Production of azo dyestuffs. May 11th.

Specifications Published.

246,526.—U. S. Industrial Alcohol Co.— Process of esterification.

247,225.—Uhde, F.—Method of synthetically producing ammonia.

270,433.—I. G. Farbenindustrie Akt.-Ges. Process for the manufacture of condensation products of crotonaldehyde.

250,990.—Harnist, C. — Simultaneous manufacture of ammonium sulphate and bisulphate and of sulphur.

263,142.—Binz, Dr. A., and Rath, Dr. C.— Process for the production of 2-oxy-3-bromo pyridine-5-arsenic acid.

Abstracts Published.

267,885.—Sulphuric acid.—Petersen, H., 6, Hohenzollernstrasse, Steglitz, Berlin.

In the manufacture of sulphuric acid in which sulphur-dioxide is oxidised by means of nitrous-sulphuric acid, only one tower, box or other enclosure is used for the actual production of acid and not more than 25 per cent. of the nitrous sulphuric acid is denitrated in this enclosure, whereby the amount of 60° B. sulphuric acid produced is at least three times the amount of nitrogen oxides, calculated as 36° B. nitric acid, which are liberated. The plant may comprise one denitrating tower, which may be rinsed with the whole of the acid from the production tower or only that portion which represents the daily yield, a production tower and one or more Gay Lussac towers. By the use of suitable packing which may be as small as 30 mm. or less and by using towers of suitable cross-section, a pressure of $\frac{1}{4}$ to 6 mm. of water per ascending metre should be employed. Towers having larger cross-sectional areas, *e.g.*, 35-150 cms 2 may also be used. Various methods of circulating the acids are described in the Specification.

268,006.—Carboxylic acids.—Bone, W. A., Montrose, Harpenden Road, St. Albans, Hertfordshire, Quarendon, R., 72a, Oakmead Road, Balham, and Gas Light and Coke Co., Horseferry Road, both in London.

Metallic acid; oxalic acid; acetic acid.—Coal or extracted coal residue is oxidised with an alkaline solution of an alkali manganate or permanganate to produe carboxylic acids consisting mainly of mellitic acid. In examples, mellitic acid together with small quantities of oxalic ,acetic and other acids are obtained from (1) a pulverised brown coal or lignite boiled in an aqueous alkaline solution of potassium permanganate, (2) a bituminous coal with or without previous extraction with benzene, treated as in the previous example, or under pressure in an autoclave.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

DAR.

478,914.—A chemical preparation, in Class 1, for regenerating sulphated batteries.—Arthur Ernest Whitelaw, 523-527, Australia House, Strand, London, W.C.2. May 18th.

BERNOS.

468,202.—Chemical substances prepared for use in medicine and pharmacy.—Taylor, Gibsons, Limited, 52, Stowell Street, Newcastle-on-Tyne. May 18th.

ACCURIN.

477,138.—Medicinal tablets for human use in the treatment of rheumatism and gout and similar ailments. — Edward James Loosmore, 120, Gleneagle Road, Streatham, London, S.W.16. May 18th.

10-TONE.

477,335.—Chemical substances prepared for use in medicine and pharmacy.—Eucryl, Limited, 5, Oakley Road, Shirley, Southampton. May 18th.

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AN ATOMIC MODEL FOR THE CHEMIST.—IV.

By FLORENCE LANGWORTHY.

It will have been noticed that in these articles I have used the word " isotope " in a more extended sense than is usual. Dr. Aston, for instance, writes of boron as having two isotopes, boron[10] and boron[11] and of lithium as having two isotopes, lithium[6] anl lithium[7], but since only fluorine[19] has been discovered he rightly describes it as having only one isotope. With our atomic model, however, we see that in order to convert fluorine[18] into fluorine[19] another positive must be put in the same place as the fluorine planet and therefore since the word " isotope " means " equal place," I use the word " isotoped " to describe what has taken place. The word "isotope" is too good to be restricted to the noun simply.

At the conclusion of the last article oxygen[16] was turned into oxygen[17], and referdnce was made to the fact that Sir Joseph Thomson and others have come across the double-positive oxygen atom. In Dr. Andrade's book, " The Structure of the Atom," there is a beautiful photograph (on p. 25), of a collision between an Alpha particle and an oxygen atom. Dr. Andrade writes: " The mass of the recoil atom in the case of oxygen here considered is in this way found to be 16.72, with a probable error of .42, which is in sufficiently good agreement with the known mass of the oxygen nucleus, 16." Such as error makes one wonder whether it may not be an oxygen[17] atom. A double-positive oxygen atom could repel the intruding Alpha particle better than the negative atom where the repulsion would only come from the sun-atom. But suoh an encounter often entails the loss of the planet to the atom, apparently, for it is significant that it is from atoms of elements of *uneven* atomic weight that Sir Ernest Rutherford is most successful in knocking out hydrogen nuclei. This we can understand since the more the number of isotoped atoms that an element has the better the chance of hitting such an atom and evicting its chief planet. An isotoped atom is not so stable as an undamaged atom. In the latter case there is one positive pulling upon to coronal electrons, but in the former there are two positives pulling upon three coronal electrons and so these electrons are not held so securely. There is a weak spot here in addition to the danger that the isotoped planet with its two positives will experience when it is repelled by the invading double-positive Alpha ray. The planet may successfully aid the sun-atom in repelling the intruder out of the atomic system, or, on the other hand, it may suffer the shock of too close a repulsion and so make its escape out of the atom. And the Alpha ray seemingly by its attraction often prevents the three coronal electrons from following the escaping planet in the orderly way that they would do if the eviction had been due to the bombardment by cathode rays. For Sir Ernest Rutherford, though he sometimes gets H_3 as the result of this Alpha ray bombardment, generally gets

hydrogen nuclei-protons. It is now thought that H_3 is triatomic hydrogen though it has not been proved to be so. Our atomic model shows us that whenever an isotoped major planet leaves the atom we shall get a ray that will—on passing out of the ray state—become an atom of an element of atomic weight three. There is a good deal of indirect evidence in favour of the identity of H_3 with nebulium. In this case the atom, while it retained its three outer electrons, would be H_3 (nebulium) but on losing the outermost of these electrons it would become the negative hydrogen atom (with two electrons) and on losing another electron it would become the neutral hydrogen atom (with one electron) or the positive hydrogen atom if the electron should be at a considerable distance, comparatively, from the nucleus.

It is said that Sir Ernest Rutherford is now doubtful as to whether he has obtained particles of mass 3 by his bombardment, but as we have seen, it is not to be expected that he should get many since his double-positive projectiles apparently attract away the electrons from the escaping planet. It is from the more natural bombardment by means of cathode particles as carried out, for instance, by Sir Joseph Thomson that one bases one's belief in H_3. With regard to one photograph, Sir Joseph writes : " This photograph is typical of what is observed when substances such as the metals platinum, palladium, aluminium, copper, zinc, iron, nickel, silver, gold, lead, graphite, and a large number of salts are first bombarded with cathode rays. The helium line generally diminishes in brightness after the bombardment has been prolonged for some hours, the " 3 " line, however, is much more persistent and in some cases, for example, that of KHO, the bombardment may be continued for several weeks without producing any diminution in the brightness of the ' 3 ' line." The helium, as Sir Joseph points out, is probably occluded helium. But we may doubt whether it is all occluded helium since Sir Joseph Thomson tells us that he has always obtained more helium from KI than from KCl. If both these salts occlude approximately the same amount of helium then it looks as if the extra amount of helium yielded by KI is due to the disintegrating effect of the cathode particles upon the iodine atoms. For if the iodine planet departs the atom becomes the twin-atom, tellurium, the outer twin of which will leave the atom as a helium atom. Thus we can understand that more helium is likely to be yielded by KI than KCl, for breaking down the chlorine will not bring one near to any helium atom. One would have to break down an atom from chlorine to potassium in order to do this and it is not probable that Sir Joseph Thomson does so. The cathode particles used, also, do not appear to have been of a wave-length that was dangerous to potassium atoms.

Sir Ernest Rutherford finds—when bombarding nitrogen—that only one out of twelve of his close shots succeeds in dislodging the proton. Such a proton has a maximum range of 40 cms. If hydrogen is bombarded instead of nitrogen the maximum range in air is 29 cms. As in the latter case it will be simply the atom of hydrogen itself that comes into collision with the Alpha particle it is easy to see that the range will be nothing like that of a hydrogen atom or proton liberated from a nitrogen atom and repelled by the same as well as by the Alpha particle. Nor is it surprising to find that the bombarded hydrogen atoms are driven forward, unlike the hydrogen atoms or protons that escape from atoms that contain a sun and system—that is to say, all atoms from lithium to uranium. For a hydrogen atom that is revolving as a planet about a central sun will be repelled backwards or forwards according to its position in its orbit when the shock comes that sets it free from the atomic system.

That Sir Ernest Rutherford has not succeeded in obtaining a proton from lithium in spite of its uneven number seems strange until we consider that, after all, the atom, when it is reduced to lithium consists only of the dying-down sun-atom, and one remaining planet. Both the planet and its coronal electrons are, comparatively, remote from the sun-region so that the repulsion will be much less intense in their case. The parting of the atomic sun and its last planet is apparently of too easy a nature to be detected by the means at our command.

With regard to lithium, Sir Joseph Thomson writes : " When examining by the aid of the positive rays the gases given out when a specimen of fluorspar from Ivigtut in Greenland was bombarded with cathode rays, I found in addition to a very strong helium line and a fairly strong ' 3 ' line, a line between the two corresponding to an atomic weight of 3.5. This fluorspar, to which attention was first called by Thomsen (*Zeits. f. Phys. Chem.*, xxv., p. 112), possesses very remarkable properties, it gives off when heated very large

quantities of helium, and when thrown upon a heated plate, shines with a bright phosphorescent light. Some other varieties of fluorspar possess this property, but none, of those I have tried, to the same extent. I have found the 3.5 line when some other specimens of fluorspar are bombarded; it is not, however, produced by every kind of fluorspar. I have also found the line when some zircons were bombarded, and occasionally in air after exposure to Alpha rays. . . . . It is difficult to account for the line by any known substance. A lithium atom with two charges would give a line in the same position, but the occurrence of the line seems to have no relation to the presence of absence of lithium."*

When we take into account the unusual amount of helium that is given off by this fluorspar we may well suspect that some of the atoms are being broken up, and as it appears that it has an impurity in the shape of the radio-active uranium, we shall not have to seek far afield for the cause. For we have seen that a bombardment by Alpha rays is a more serious matter for the atom than a bombardment by cathode particles. The latter must be of a wave-length that is dangerous to the atom bombarded in order to do any damage. But any Alpha particle by penetrating an atom may give its chief—and therefore most lively—planet a shock that will cause it to pull out a coronal electron. The sun-atom will thereupon repair its damaged planet by "occluding" a negative particle, the positive of which will be thrown to the planet while its two electrons will be repelled into the corona to join the one coronal electron remaining. The next Alpha particle that succeeds in making its way into the atom will—if it comes near the planet—do still more damage since the shock will now enable the planet to make its escape. If we, then, picture fluorine atoms as being in close proximity with uranium atoms throwing off Alpha particles, we can understand that in the course of ages such atoms will be reduced from fluorine to oxygen and from oxygen to nitrogen and so on until they become lithium and finally helium.

"Apart from a new element," writes Sir Joseph Thomson, "the only explanation I can think of which is not flatly contradicted by the evidence on the photographs is that it is due to a doubly charged compound of H_3 and He; both these gases are present whenever the 3.5 line is visible, and the 3.5 substance is got by bombarding a mineral in which both helium and hydrogen are present. . . . It is in favour of the view that '3.5' is a compound of He and H_3 that the space between the 3.5 lines and both the H_3 and the He lines is filled with faint luminosity, indicating that the 3.5 substance while passing through the electric fields dissociates into He and H_3."

The evidence is certainly in favour of 3.5 being the doubly-charged lithium atom.

In Dr. Andrade's book, "The Structure of the Atom" (Third Edition), there is another beautiful photograph (p. 101) showing what is supposed to be the disruption of a nitrogen nucleus by collision with an Alpha particle and the expulsion of a proton. As the evidence seems to indicate that the heavy nucleus is of mass 17 or near this figure, it is suggested that the Alpha particle has joined up with the nitrogen atom. This is not credible, however, with our atomic model as the repulsion between the two double-positives should suffice to carry them too far apart to admit of any union taking place. Dr. Andrade also comments on the fact that the fork made by the tracks shows two prongs instead of three, "as might be expected to correspond to proton, broken nucleus, and Alpha particle after collision." One is therefore led to suspect that either an isotoped nitrogen atom (15) or an isotoped oxygen atom (17) has successfully repelled an Alpha particle—without loss of its planet—or that the thin, beaded track is made by an electron that has been lost by the atom owing to the absorption of an X-ray. In this case the mass of the nucleus would be 15 if nitrogen and 17 if oxygen. The possibility of oxygen contamination of the nitrogen bombarded cannot be ignored.

To return to the breaking-down of our atom, which we left as nitrogen (A.W. 14.01). On gaining an isotope its weight rises to 15, and the departure of the planet with coronal electrons, 15, 14, 13, as a major planet X-ray makes the atom carbon (A.W. 12.003). An isotope brings this up to 13. The flight of 13, 12, 11, leaves the atom boron, 10. An isotope raises this to 11 (A.W. 11.03). Dr. Aston finds that boron has a line at 11 as well as 10. When the time comes for 11, 10, 9, to fly off, the atom becomes beryllium, 8. This is raised by an isotope to 9 (A.W. 9.2). Beryllium's weight points to most of it being isotoped, as does its Positive-ray spectrum. "A

* Sir Joseph Thomson, O.M., F.R.S., *Rays of Positive Electricity*, p. 203.

single strong parabola corresponding to the atomic weight 9 (Na 23)." When the beryllium planet and its isotope, 9, 8, 7, go, they leave the atom lithium, 6. An isotope raises this to 7 (A.W. 6.94). This element is, apparently, mostly isotoped. "A strong parabola at 7" points to the double-positive, while "a weak one at 6" points to the single positive, the planet having for the time being lost its negative hook.

The departure of the lithium planet and its isotope, 7, 6, 5, is seemingly followed by that of the electron-planets. These must have been put to a severe strain by the flight of all these ionised positives and when the last goes—taking with it the last repelling negative—the electron-planets, 4, 3, evidently fly after it. So the damaged sun-atom, 2, is left, bereft of its electron-planets. But now that they are gone it can unite with the nearest negative particle and again become 4 in weight. It cannot supply itself with new electron-planets by means of this union, since the positive body of the particle that supplied the former ones is still in place, and no more positives are wanted there. Nor can it turn the negative particle into a planet, and thus circle itself with two coronal electrons, since there are no electron-planets to drive the particle upon it. The attracted negative can remain at a discreet distance albeit its two electrons are drawn in attraction towards the double-positive while its positive body is repelled by the same. But the combination is no longer an active sun-atom; it is only an atom of yellow- inactive, helium.

General Notes.

THE CHEMICAL INDUSTRIES OF CANADA, 1926.

The Dominion Bureau of Statistics at Ottawa has forwarded to the High Commissioner for Canada in London a preliminary summary report on the production of Chemical and Allied Products in Canada during the calendar year 1926.

From this statement it appears that substantial progress was achieved by the Canadian Chemical Industry last year. Production by the 533 plants reporting in 1926 was valued at $120,369,518, an increase of 7.5 million dollars over the reported value of sales in the preceding year and the highest on record since 1920 when enhanced prices partially accounted for the high value of production at $124,545,772; volume production in 1926 was the greatest since the war period. Capital employed at $132,279,179 was also the highest since 1918 and was nearly six million dollars above the figure for 1925. Employment showed an increase to 14,313 from 13,951 in 1925, and the yearly salary and wage earnings stood at $18,158,614 as against $17,469,157 in the previous year. Materials used cost $59,756,675, an increase of 3.5 millions over 1926.

Coal Tar and its Products.

The eight tar-distilling units and seven plants manufacturing disinfectants in 1926 gave employment to 190 people and produced commodities valued at $2,912,443, an increase of $319,622 over the sales value of the 1925 output. Capital employed at $4,208,697 represented an increase of a million dollars. The principal products were creosote oil and other special oils, pitch, refined tar, cresylic acid, tarred felts and sheathings, roofing cement and disinfectants.

Acids, Alkalies and Salts and Compressed Gases.

Production of industrial chemicals and gases was greater in 1926. The 43 plants in this industrial group employing a capital of $38,186,983 furnished employment to 2,406 workers the year round and converted $13,210,804 worth of raw materials into finished products valued at £28,717,401 (an advance of 1.2 million dollars over the total output value for 1925. Sulphuric, hydrochloric, nitric and acetic acids, caustic soda, salt cake, calcium carbide cyanamide, liquid chlorine, phosphorus, oxygen, carbon dioxide and acetylene were among the leading products. Industrial chemicals were made in 20 different plants and compressed gases in 23 establishments.

Explosives, Ammunition, Fireworks, and Matches.

Production value of explosives, ammunition, fireworks and matches was maintained at about the level of the preceding year. Explosives were made in 5 plants, ammunition in 3, fireworks in 3 and matches in 4 establishments. The 15 plants gave work to an average of 2,173 people, to whom $2,280,012 was paid in salaries and wages and manufactured products worth $12,307,752. Materials used cost $6,902,909 giving thus $5,404,843 as the value added by manufacture. Capital employed stood at $17,239,592. The main products for sale

were dynamites, monobels, gunpowder, nitrate mixtures, safety cartridges, safety fuses, percussion caps ,detonators, railway signals, manufactured fireworks and matches.

FERTILISERS.

Production of manufactured fertilisers in 1926 amounted in value to $1,516,685, a gain of $100,000 over the output value reported in 1925. Twelve plants were in operation, capital employed stood at $1,818,743, employees numbered 214 and payments in salaries and wages totalled $204,246. Materials used cost $1,033,680 and the value added by manufacture was only $483,005. This industry covers only those firms making complete fertilisers. Commodities such as cyanimide, ammonium sulphate, tankage, dried blood, etc., are classified in other industries. Imports of fertilizer material were valued at $3,692,680 and exports at $4,664,316.

MEDICINAL AND PHARMACEUTICAL PREPARATIONS.

There were 126 plants in operation in this industry in 1926 as compared with a total of 120 in the preceding year. Production for the year was valued at $15,145,641 as against $13,987,849 in 1925. Employees numbered 2,358 and their yearly earnings totalled $2,842,662. Imports of medicinal and pharmaceutical preparations and other drugs ·totalled £$,100,911 as against $2,968,089 in 1925.

PAINTS, PIGMENTS AND VARNISHES.

Production in the paints, pigments and varnishes industry advanced 2.5 million dollars above the figure for last year and amounted in value to $24,702,385. Sixty-three plants were in operation during the year employing a capital of about 23 million dollars and used raw materials worth $12,947,639 in the manufacture of commodities for sale. Employees averaged 2,471 in number as against 2,355 in 1925. Imports totalled $4,377,998 in 1926 and exports were worth $502,183.

SOAPS, WASHING COMPOUNDS AND TOILET PREPARATIONS.

This industry also showed a substantial increase in production value during 1926. The sales value of output in that year totalled $18,908,991 as against $17,388,506 in the preceding year. More than 2.5 million dollars was paid to the 1,997 employees. Raw materials cost $10,910,278. Capital employed stood at $17,021,005 as against $16,731,558 in 1925. Thirty-eight concerns produced soaps chiefly, 22 were classed as manufacturers of washing compounds, and 40 as makers of toilet preparations as their principal product. Imports of soap reached a value of $1,199,893 and exports, to $783,261.

INKS, DYES AND COLOURS.

Printing inks, writing inks, dyes and dye soaps, printers' rollers, caramel, mortar colours, stains, mucilage and paste were the main products of this industry. In 1926, there were 26 plants in operation and production was well maintained at $2,800,871. Capital employed amounted to $2,705,266 and the number of workers stood at 438. Seven plants made writing inks as the main product, 13 made printing and lithographic inks and printers' rollers, and 6 made dyes and colours.

WOOD DISTILLATES AND EXTRACTS.

Production showed a slight decline in value to $1,734,993 as compared with $1,989,996 in 1925. Only 9 plants were in operation, capital employed stood at $2,217,049 and the 255 workers were paid $214,694 in salaries and wages during the year.

MISCELLANEOUS CHEMICAL INDUSTRIES.

In addition to the industries reviewed in the preceding paragraphs there were 124 plants producing other chemical products of various kinds in Canada during 1926. The output of these factories reached a value of $11,592,356 from materials which cost $5,461,224. More than 1,800 persons were employed. Adhesives, baking powder, boiler compounds, celluloid products, flavouring extracts, insecticides, polishes, and dressings, sweeping compounds and other chemical products are included in this group.

Imports of chemicals into Canada showed a substantial increase over 1925, while exports were considerably lower. Total imports for the year, of chemicals and allied products, had a value of $31,358,384 as compared with $27,653,819 in 1925. Important gains were recorded in the fertilisers, paints, and inorganic chemicals groups, while nearly all other classes showed small gains. Sixty-four per cent. of all imports came from the United States, 16 per cent. from United Kingdom, and 20 per cent. from other countries, chief among which were Germany, France, Netherlands, Chile, Argentine, Belgium and Switzerland.

Exports were valued at $16,308,773 as against $17,490,254 in 1925. Cyanamide, calcium carbide, sodium cyanide, acetic acid, soaps, cobalt oxide, were among the

most important items on the list. Of the total, 50 per cent. of Canada's exports of chemical products went to the United States, 20 per cent. to the United Kingdom and 30 per cent. to other countries, chief among which were Mexico, Japan, Newfoundland, Portuguese Africa, Cuba, New Zealand, Barbados, Australia, China, and Chile in the order named.

Prices of chemical products remained at about the same level during 1926. Based on 1913 prices as 100 the Bureau's index number for chemicals and allied products, which showed an average of 157.1 in 1925 was calculated at 157.8 for 1926 with only slight variations from month to month.

The Canadian Chemical Industries with their allied branches of manufacture represent not less than one-fifth of the manufactures of the Dominion. In 1925, 1,400 concerns using chemical processes made products valued at $655,000,000, the aggregate value of all manufactured products in Canada in that year having reached $2,678,000,000; employment in these industries totalled close on 87,000 persons; and salaries and wages almost $110,000,000. The industries in question bought materials in 1925 for manufacturing at a total cost of $334,000,000 and produced a variety of commodities having an aggregate factory value of more than $655,000,000.

The report under review deals primarily with such industries as manufacture chemicals and allied products, along the lines followed in previous issues. Certain features enhance its value considerable; alphabetical lists of all the products made and materials used in the various industries included in the survey have been prepared, the convenience of which will be apparent; comprehensive data have been compiled on the imports and exports of chemicals, the statistics showing the imports and exports for (a) the average for the five fiscal years ending March 31st, 1924; (b) the fiscal year ending March 31st, 1925; and (c) the fiscal year ending March 31st, 1926. Following the general review of the industry and the general tables relating to all the industries and to their distribution by provinces, are several chapters each of which presents all the statistics relating to a particular industry.

Another feature of the report is the in clusion of statistics relating to those industries which use chemical processes in the manufacture of products not usually described as chemicals. Students in this broader field will find this comprehensive table more useful than the more restricted compilation which deals only with the output of recognised chemical products.

Copies of the Report in question may be obtained by parties interested on application to the Natural Resources and Industrial Information Branch, The Canadian Building, Trafalgar Square, London, S.W.1.

BOARD OF TRADE ANNOUNCEMENT.

Merchandise Marks Act, 1926. Proposed Exemption of Uncompounded Drugs.

The Board of Trade have given notice of their intention to exempt Uncompounded Drugs from the requirement that imported goods bearing a British name or trade mark must also bear an indication of origin. This exemption will not extend to proprietary articles, or to articles sold in their original packing.

Any communication on the subject should be addressed within fourteen days to the Secretary, Board of Trade, Great George Street, Westminster, S.W.1.

DEPARTMENT OF OVERSEAS TRADE.

H.M. Trade Commissioner Service in South Africa.

With reference to the notice regarding the resignation by Major G. Fetherston, D.S.O., M.C., of the post of H.M. Trade Commissioner at Cape Town, the Department of Overseas Trade announces that the vacancy has been filled by the appointment of Mr. J. W. Brigden.

American Farm Equipment Manufacturers.

The British Consul-General at Chicago has forwarded a copy of the Proceedings of the Thirty-third Annual Convention of the National Association of Farm Equipment Manufacturers, which was held at Chicago in October last.

The Report may be consulted by British firms interested on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

QUACKERY.

India and the United States of America seem to be the quacks' paradise on earth. But while the medical profession and the Government of U.S.A. are trying their best to suppress this evil, the medical men in India and our Government appear to be quite apathetic.—*Indian Medical Record.*

MONKEY GLAND TRANSPLANTATION.

An extraordinary vista of the future, when man would live for 140 years, was opened up by Dr. Serge Voronoff, the celebrated surgeon in a lecture on gland transplantation which he gave in Paris at the weekly luncheon of the Anglo-American Press Association.

He saw absolutely no reason, he said, why men in the near future should not be able to live until the age of 125 or 140 years. During the whole of their lifetime, by the method of gland transplantation, they ought to be able to enjoy the fullest mental and bodily health. Old age, when it did come, would be sudden and short and after but three months or less of decrepitude they would painlessly sink to their graves.

Giving accounts of his main operations in grafting so far, namely, the transplantation of endocrinal glands from a monkey to a man, Dr. Voronoff said that he had now carried out 1,000 such experiments and that they were practically all successful.—*Indian Medical Record.*

Under ordinary conditions, the United States have a large export surplus of hog products, but just now domestic supplies are insufficient for their needs.

Recent studies by Professor Bowley and Sir Josiah Stamp indicate that annual per capita production in Great Britain is now at least equal to that attained in 1911.

Of Great Britain's imports of live animals, the greatest number come from Ireland with an annual value of about eighteen million pounds, as compared with imports from Canada about ten millilon dollars.

The largest single consignment of salmon eggs ever shipped in Canada was that made by officers of the Fish Culture Service of the Department of Marine and Fisheries to the upper waters of the Fraser River in British Columbia. Fifteen million sockeye eggs, in the "eyed" stage, were transferred in specially constructed crates from the Dominion Government's fish hatchery at Pemberton on the Fraser River below Hell's Gate canyon to the following spawning grounds in the Upper Fraser: Stuart lake, Francois lake, Bowron lake, and the Quesnel lakes.

LIEBIG'S EXTRACT OF MEAT COMPANY, LIMITED.

An interim dividend in respect of the year ending 31st August, 1927, will become payable on and after the 30 June next at the rate of seven shillings per share free of income tax, to the proprietors of ordinary shares registered on the company's books on the 16th June. In respect of Coupon No. 88 of the ordinary share warrants "to Bearer," such interim dividend will be payable on and after 30 June next at the company's bankers, Messrs. Glyn, Mills and Co., 67, Lombard Street, E.C.3. Coupons must be left three clear days for examination before payment. Coupons may also be presented in Antwerp at the Banque Centrale Anversoise, for payment at the short exchange on London.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting on Thursday, June 2, 1927:—

A Theoretical Discussion of Certain Elastic Constants of Calcite and Crystalline Sodium Nitrate. By S. Chapman, F.R.S. and A. E. Ludlam.

Upper limits are found theoretically for two of the elastic constants of calcite and crystalline sodium nitrate; the calculations are based on the theoretical determinations of the potential energy of these crystals in various configurations, made by Topping and Chapman, and by Lennard-Jones and Dent. Voigt has measured the elastic constants for calcite, and the theoretical upper limits found in the present paper prove to be larger than the measured values but of the same order of magnitude.

The Dissociation of Carbon Dioxide at High Temperatures. By R. W. Fenning and H. T. Tizard, F.R.S.

If mixtures of carbon monoxide, oxygen and nitrogen are exploded, the explosion pressure is greatest when there is an excess of carbon monoxide in the mixture. If

no nitrogen is present, the explosion pressure is greatest when the ratio $CO/O_2 = 2$, and varies very little with the composition of the mixture near the maximum point.

When nitrogen is present, a determination of the composition of the mixture which gives the greatest rise of pressure on explosion, leads to a simple method for determining the dissociation of CO_2 at high temperatures; for if the equilibrium at the maximum temperature is represented by the expression

$$2(1 + a) CO + O_2 + bN_2 \quad 2(1 - x) \quad CO_2 + 2(a + x) CO + xO_2 + bN_2,$$

then it can be shown that $x = a/b$.

The experimental results obtained are very consistent, and indicate that the accepted values for the dissociation of CO_2 at high temperatures are much too high.

The Influence of Boundary Films on Corrosive Action. By L. H. CALLENDAR. Communicated by H. C. H. Carpenter, F.R.S.

The local corrosion of metals in normal waters is governed by boundary films, of solid, liquid, or gaseous nature, present on the metal surface.

The surface of those metals liable to local corrosion is normally more or less covered with an oxide film; where this film is of higher potential than the metal itself, its distribution determines the location of the primary cathode and anode areas before the metal comes in contact with the electrolyte. The distribution of this oxide film is determined by the presence of foreign substances on the metal surface and by irregularities in the surface itself.

When metal and electrolyte come into contact, the oxide film is the primary cathode, metal passes into solution at unoxidised parts of the surface, and experiments show that continuance of this current between cathode film and metal is dependent on prevention of diffusion of oxygen to anodes; they also idicate that original location of cathode and anode areas is likely to be altered by distribution of oxygen within the solution.

Boundary resistance between electrodes and electrolyte is an indicator of rate of corrosion; the normal cathodic oxide film formed in air is so thin that it has little effect on rate of corrosion, but thicker oxide films formed by heating give high boundary resistance and must tend to retard corrosive action; oxidising electrolytes also retard by increasing boundary resistance.

With aluminium, boundary resistance increases with increasing dilution of electrolyte and increasing thickness of any oxide film present on the metal surface.

The Cause of the Colours Shown During the Oxidation of Metallic Copper. By F. A. CONSTABLE. Communicated by T. M. Lowry, F.R.S.

A considerable body of evidence has been collected showing that interference is the cause of the colours shown during initial stages of oxidation. The order of production of the colours corresponds with the order tabulated by Rollett for interference colours of air films of increasing thickness seen by transmitted light. Fall in electrical conductivity and mass of oxygen taken up per unit area of surface are proportional to the equivalent air thickness of the copper oxide film, *i.e.*, the thickness of the air film which would produce the same colour. The wave-lengths of the maxima in absorption or reflection bands, in the spectrum of light reflected from the film, move towards the red as the thickness of the film increases. First-order colours are characterised by a single absorption band in the violet travelling toward the red. A reflection maximum then appears and moves toward the red. As it approaches the red a second absorption maximum appears in the violet and the second-order colours are produced. Finally, general absorption causes blackness of film.

The thickness of oxide film, calculated from mass of cupric oxide per sq. cm. of metallic copper and its density, agrees with the value obtained by spectrophotometric measurements, using Kundt's values for the refractive indices of cupric oxide.

THE CHEMICAL SOCIETY.

Thursday, June 2.

The Passivity of Metals. Part I. The Isolation of the Protective Film. By U. R. EVANS.

When vacuum-fused electrolytic iron is rendered passive in potassium chromate solution, and then subjected to anodic treatment in sodium chloride solution, the

metal is dissolved away, leaving, along with certain secondary products, a transparent envelope which retains the shape of the original. A transparent skin can also be removed from passive iron by dissolving out the metal from below by means of iodine. The same method can be used to remove the visible films responsible for the temper-colours of heat-tinted iron; in all cases the transparent films consist of ferric oxide. Relatively thick (visible) films tend to crack and are non-protective, whilst the films produced by unduly short exposure of cold iron to air are discontinuous. To produce passivity, the films must be continuous. The films responsible for passivity possess thicknesses too small to show interference tints, but the thickness varies with the conditions of production, and particularly with the presence of internal stresses in the metal, which tend to cause cracking and thus allow the films to thicken locally; the thickness varies considerably from point to point. Chlorides favour the activation of passive iron, because chlorine ions can pass through the membrane, and under anodic conditions the metal is dissolved away below the skin, which becomes loosened; mere immersion in a chloride solution, under conditions which preclude the flow of local currents, causes no reversion to activity. The rather unreliable passivity produced in electrolytic iron by nitric acid has been investigated. Transparent films have been isolated from the surface of passive copper and aluminium.

Studies of Valency. Part VIII. The Molecular Structure of Vernon's Dimethyltelluronium Salts. By T. M. Lowry and (Mrs.) R. R. Goldstein.

The absorption of Vernon's dimethyltelluronium halides increases progressively from α-$TeMe_2Cl_2$ to α-$TeMe_2I_4$. The α- and β-dibromides each show a marked step out; the α- and β-diiodides and the α-tetraiodide show the twin maxima already recorded in CHI_3 and in KI_3. The results are in harmony with a suggestion, derived from the electronic theroy of valency, that only one halogen can be ionised at a time, as in the formula $\overset{+}{[TeMe_2X]}\overset{-}{X}$.

In the quadrivalent compounds of tellurium, the third valency is a covalency and the fourth valency is an electrovalency. Similarly, in the quinquevalent compounds of phosphorus, arsenic and antimony, the fourth valency is a covalency and the fifth an electrovalency. In general it appears that, whenever the normal valency of an element is increased by two units, one of the additional valencies is a covalency, and the other is an electrovalency.

Factors Controlling the Formation of Some Derivatives of Quinoline, and a New Aspect of the Problem of Substitution in the Quinoline Series. By E. Roberts and E. E. Turner.

The quinoline condensation is greatly affected by the nature of the substituent. The effect produced is apparently due partly to the directive influence of the substituent, and partly to an influence it produces corresponding with its influence in diminishing the basicity of the aniline molecule when present as a substituent in the latter. Thus, provided one strongly *ortho-para* directing group is present in position 3(5), ring closure readily occurs, even if a second similar group is present in the unfavourable positions. On the other hand, of the three anils derived from the chloroanilines, only the *meta* compound undergoes the condensation, whilst of the anils derived from 2 : 4-, 2 : 5-, 3 : 5- and 3 : 4-dichloroaniline, only the last has been converted into a quinoline derivative. The non-condensation of the 3 : 5-compound shows that steric factors may operate.

The Baeyer method of quinolone synthesis is also influenced by steric factors, which do not appear to operate in the Skraup and Doebner-Miller syntheses.

The nitration of 2 : 4-dimethylquinoline and of a number of its chloro-derivatives has been studied, and a new conception of the essential quinoline molecule has been obtained.

Substitution in the quinoline series is not controlled by the nitrogen atom, but simply by 5 : 8 reactivity, corresponding with the reactivity of the four α-positions in naphthalene. In substituted quinolines, 5 : 8 reactivity has as much orienting effect as the substituent itself, at any rate in the cases of Cl, Me and NO_2.

THE UTILISATION OF GAS COKE.

By E. W. Smith, D.Sc., F.I.C.
(Technical Director, Woodall-Duckham Companies.)
(*Read before the Royal Society of Arts, March* 9, 1927.)

Summary.

It is desired that I should explore the subject of the utilisation of gasworks coke.

Commercially, there is only one other type of coke available, and that is made at coke ovens, and used largely in metallur-

gical operations. Each is a product of the distillation of bituminous coking coals, although in recent years it has been shown that by correctly blending non-coking coals with coking coals good coke may be made. Coke oven coke is usually denser, harder, less combustible, lower in ash and moisture than gas cokes. It is the main product of the coking industry, while gas coke has been what is known as a residual, though by far the most important residual. Six shillings a ton difference in the selling price of coke will affect the selling price of gas by about a halfpenny a therm.

During the last two years, we have had presented to us a large number of technical contributions on the subject of coke—its formation, its combustibility, its reactivity, grading, quenching, and so on—but there is still a lot to learn. This technical activity has been stimulated largely through two or three causes—the public desire for smoke abatement—the activities of those engaged in the development of processes of low temperature carbonisation, and because of the non-success of the latter commercially, an attempt on the part of those engaged in the well-established high-temperature carbonisation industries so to improve the coke residue as to provide a solid smokeless fuel.

Such technical contributions have laid the foundations for progressive technical development, and already a great change is taking place in many gas undertakings.

Attempts are being made to carbonise a greater proportion of low ash or cleaner coals. More collieries are consequently installing coal cleaning plants, and in one case—Glasgow—a gas undertaking is itself arranging to clean its coals. In all such cases lower ash coke will be available. Then methods of coke quenching in many cases are given more attention where static methods of carbonisation are used, and with the enormous growth of continuous vertical retort practice, dry coke from such plants may be assured.

Coke screening and grading—for its different uses—is becoming quite common, and last, but by no means least, the apparatus of all kinds in which coke is burnt is being modified and improved.

The possibilities of such progressive development are observable in those large cities that have taken advantage of recent developments, when it is realised that the demands for the improved coke are so great that in some cases there is an actual shortage.

The time may not be very distant when coke will take its place on an equal footing with gas in the economics of gas undertakings, and whilst periodic fluctuations in the coke demands can be taken care of by stocking, the seasonal fluctuations of gas not taken care of by the holders, can be used for heating the carbonising plants.

The coal carbonised in gasworks is approximately 18,000,000-tons per annum, and the total coke made, including breeze, is nearly 12,000,000-tons.

This is disposed of approximately as follows :—

	Tons.
Coke used on producers for heating retorts	3,282,748
Coke used for water gas manufacture	1,153,413
Coke for export	889,281
Coke for home consumption	6,507,400
	11,832,842

Of the 6½ million tons of coke available for home consumption, probably 700,000 tons represent the weight of coke breeze, and fines, and the remainder represents the amount available, when sized and graded for its varied applications, or domestic and industrial uses.

The amount of *coal* used for domestic purposes is about 40 million tons.

There is a large amount of technical coke development work being carried out for the Gas Industry. Contributions have already been made by different members of the staffs of Leeds and Sheffield Universities. The Birmingham Gas Department, The Gas Light & Coke Company, the South Metropolitan Gas Company, and the Newcastle Gas Company are each carrying out important technical work in this direction, and no doubt there are many others.

Domestic Uses of Coke.

The heating of rooms, and the supply of hot water, enter into the domestic economy of all households in this country, and I need make no apology for treating this subject at some length. Whilst the heating of rooms may be carried out independently of the supply of hot water, it is generally found convenient and economic to carry out the two operations by the same apparatus. We are all familiar with the open grate fitted at the back with a hot water boiler, and it is necessary to review the methods and apparatus by which gas coke

is utilised for room heating alone, and for heating rooms in combination with water heating.

THE OPEN GRATE AND ITS MODIFICATIONS.

The increasing price of coal of recent years has led to the substitution, in many instances, of the old-fashioned open grate, with its abundance of iron bars, side and back plates, and its excessive air supply, by the slower burning semi-well and well grates. The back and sides of this type of grate are invariably of firebrick, and the front bars are absent. Gas coke, providing it is reasonably dry, and sized between 2in. and 1½ in., may be burnt in any such grate which burns coal successfully. The coke may be ignited by paper and wood in the ordinary way, or by using a gas jet. Thereafter, all that is required is to keep the fire replenished, throwing the fresh coke to the back of the fire. It is desirable that the fire should not be allowed to burn too low before replenishing. Dry gas coke graded to between 2in. and 1½in. will keep an ordinary sized room (say 12ft. by 14ft.) warm when burning at the rate of about 2lbs. per hour, which, with coke at 40s. per ton, is equivalent to a cost of about ½d. per hour.

In the " Glow-Worm " open fire, the coke is held in the form of a vertical layer between widely spaced bare at the front, and closely spaced bars at the bottom and back. The fuel is fed through the canopy, which is hinged, and opens for this purpose. The ashpan acts as a damper, and when starting from cold it is pushed right back, the air for combustion being drawn through the front bars, through the fuel bed and up the back flue to the chimney. Under this condition, the whole of the chimney pull is itilised in drawing air through the fuel bed, and the fuel bed increases in temperature at a very rapid rate. To continue to drive the fire in his way at the full rate would lead to an unnecessary wastage of fuel. By drawing forward the ashpan, the direction of the air current may be progressively diverted from the horizontal from front to back to the vertical from bottom to top, and the rate at which the fuel burns reduced.

Thus, after the fire has attained a useful temperature by means of the full draught, a position of the ashpan may be found which is just sufficient to maintain the fuel at that temperature. To preserve the ventilating effect of the ordinary open fire, an auxiliary opening underneath the canopy allows air to be drawn into the chimney by the injecting action of the hot products of combustion, and thus the air of the room is changed sufficiently often to preserve its freshness.

In the " Rayflex " fire, the fuel is supported on inclined fire bars with a practically closed front. The air for combustion is drawn through the top of the fire and downwards through the firebars, and up the back of the fire to the chimney. If desired, a boiler may be placed behind the firebars. The rate of combustion is under control by means of air slides, the ash box under the firebars, and by a damper at the top of the back flue.

Behind the canopy and above the fire is a perforated plate which permits an amount of air to be drawn directly into the chimney for ventilating the room. The heat passes into the room from two sources.

(a) By direct radiation from the surface of the fire, and

(b) From convection from the front plate and the canopy.

In lighting this fire with paper and wood, the process used is the reverse from that adopted with the ordinary open grate. Coke is first placed on the firebars, then the wood, and then pieces of lighted newspaper are thrown on the wood. As soon as the wood is well alight, more coke is piled on the wood. In a very short time the zone of combustion, which travels upwards to the source of the air, *i.e.*, the surface of the coke, is radiating heat into the room, and thereafter the only attention required is a slight disturbing of the fuel with the poker, and the addition of fresh fuel.

It is calculated that 55 per cent. of the heat in the coke passes into the room by radiation, and 17 per cent. by convection. There is no carbon monoxide in the waste gases. The size of gas coke recommended is ½in. to 1in., but other grades varying somewhat from this, may be used. The coke consumption of the grate is stated to be about 2lbs. per hour over the day's run.

PREPARATION OF FOODSTUFFS.

This industry, which touches one of the most intimate sides of our life, is represented by the use of gas coke in bakers' ovens. The heating of the baking decks is carried out by means of steam loop tubes in which water is evaporated under pressure placed in the roof and sole of the deck. The necessary heat is supplied by burning large gas coke screened over 2in. in furnaces, attached to the ovens. Since the baking operations are carried out at com-

paratively low temperature, steam is a convenient means of obtaining such temperatures without the oven being overheated in any part, and, under normal conditions, firing by gas coke is the cheapest means of obtaining the steam.

To turn to the preparation of another foodstuff, probably the enormous extent of the fish frying trade is not fully realised. Something like 5,000 tons of fish per week finds its way accompanied by the ubiquitous "chips" on to the tables of our country. Large coke screened over 2in. is a suitable fuel for heating the "frying" pans of the fish shop. The advantage of coke as against coal apart from its price in this connection is its freedom from smoke, and its comparative cleandiness. It should however, be stated that the superior advantages of gas, even at a higher cost, is being realised, and in many cases all forms of solid fuel are being displaced.

Production of Industrial Gases.

Gasworks themselves are very large users of coke. Of the 11,800,000 tons of gas coke made in this country, about 4,400,000 tons or over 37 per cent. is used on the Gasworks themselves in the manufacture of producer gas for heating the retorts and water gas for admixture with the coal gas.

Over three million tons of coke are used per year by the gasworks for the heating of the retorts, and the actual volume of producer gas obtained from this coke is greatly in excess of the coal gas made for distribution in the area of supply.

The type of producer almost exclusively used is the fixed grate producer with refractory walls.

Water Gas Manufacture.

The modern trend of town's gas manufacture is to obtain a mixed coal and water gas direct from the gas retorts by introducing steam into the retort whilst coal gas making is proceeding. Where, however, the type of retort does not admit of this, the water gas is produced in a separate plant from large screened coke. In fact, about 10 per cent. of the total gas coke made is used for this purpose. The type of machine usually used consists of a generator where a bed of coke is alternately brought to a high state of incandescence by an air blast, and then the heat thus stored is absorbed by passing steam through the hot coke. In contact with the coke, the steam is dissociated, the gaseous products of the reaction being hydrogen and carbon monoxide. This mixture of gases is cooled, purified, and then mixed in definite proportions with the coal gas made direct from coal. In carburetted water gas machines, "blue" water gas passes immediately from the generator through another vessel where oil is sprayed on to heated refractory material. The vapours of the oil are carried with the water gas into yet a third vessel where in continued contact with heated refractory material the oil vapours are converted into permanent gases. Gas of calorific value from 300 to over 600 B.Th.U. per cu. ft. may be obtained by varying the amount of oil used. It is most desirable that gas coke for use in water gas machines should be large coke free from small coke, and should not have a highly fusible ash, otherwise clinker trouble will be experienced. As a very useful figure, it may be taken that using a gallon of gas oil increases the calorific value about 100 B.Th.U.'s per cubic foot. Generally speaking, there is about 52,000 cu. ft. of blue water gas made per ton of coke, and about 90 cu. ft of oil gas per gallon of oil. The necessary steam may be raised from waste heat obtained during the periods when the coke is being "blown" with air, but steam may be obtained from an outside source when about 8lbs. of coke or breeze will be required to be consumed under boilers per 1,000 cu. ft. of water gas made.

I think I have shown you enough to prove that coke is one of the chief economic factors in our national life. The multitude of its applications and uses, its advantages over the use of coal, its controllability, its cleanliness, and its availability all commend it as a type of fuel that is worthy of still further development and improvement. It is fortunate that it is a product of a thoroughly progressive industry, employing technicians that are fully alive to all the possibilities, and I have no doubt that in the very near future, just as we have a number of Gas, Light and Coke Companies, all gas undertakings will so recognise the national importance of the solid fuel they produce, that eventually we shall not have just a Gas Industry, but a Gas and Coke Industry—or even a Fuel Industry. Then coke will have truly come into its own, and it will have the attention of research chemists, engineers and commercial men it deserves.

THE PHYSICAL SOCIETY.

Proceedings at the Meeting held on Friday, May 13, 1927, at the Imperial College of Science, London, Prof. O. W. Richardson, M.A., D.Sc., F.R.S., in the chair.

Mr. Henry Rowe, B.Sc., was elected a Fellow of the Society. The President announced that the Council had elected Mr. Alfred Harold Steed a Student Member.

The following paper was read :—

The Theory of Luminescence in Radio-active Luminous Compound. By J. W. T. Walsh, M.A., M.Sc., F.Inst.P.

Abstract

Previous work on this subject is reviewed, and the results of brightness measurements on zinc sulphide compounds containing radium are given for periods up to 4,000 days. From a comparison of the brightness curves of compounds made with the same luminescent material but with different radium concentations it is shown that the brightness-time relationship is of the form $B = rf(rt)$, where r is the radium content.

The experimental facts available for developing and testing a theory of the luminescence are summarised, and a number of different theories, including a modified form of the recovery theory, are considered.

Finally, it is shown that the observed brightness curves are in excellent agreement with Rutherford's original theory of the destruction of active centres, provided this be combined with a simple hypothesis as to the cause of the progressive increase in the light absorption of the material which has been found experimentally. This leads to the following form of the brightness-time relationship:—

$$\log [B/(b + B)] + kt + a = 0.$$

where a, b and k are constants, of which the last two are proportional to the radioactive concentration for any given grade of luminescent material.

From the results obtained on two grades of compound it is concluded that (a) the rate of destruction of active centres is six to nine times that of the ionisation of inactive molecules, and (b) in the new material used for the compounds measured, 20 to 50 per cent. of the molecules are in the active state.

Discussion.

Lord Rayleigh pointed out that since the radio-active material was mixed with the luminescent material throughout the experiment, it had been impossible to test the effect of rest on the latter of these materials. He was glad that the author had succeeded in disentangling the facts in spite of this difficulty, but he would like to suggest that future investigations might be simplified by separating the constituents of the luminous compound. He had recently been using the natural luminosity of certain uranium salts as a photometric standard in the study of the light coming from the sky at night. Uranium nitrate, for instance, is luminescent in response to light or to the action of radio-active substances, and consequently is faintly self-luminous in response to the uranium which it contains. It would be interesting to subject it to the influence of radium emanation or some similar substance, and to find out whether its luminescence can be fatigued. Although the luminosity of ruanium salts is much fainter than that of the compound discussed in the paper, it is practically permanent, and its marked difference in this respect might be worth investigating.

Dr. H. Borns : Can the author say anything further about the influence of purposely added impurities, to which he has only referred in his introduction?

Dr. D .Owen asked whether anything was known as to the nature of the "active centres." Did the spectrum of the emitted light give any information on this subject?

The Author ,in reply, to the discussion, said that the separation of the constituents of the compound, as suggested by Lord Rayleigh, would certainly afford the right method for a more fundamental investigation than that described in the paper, but the latter had been concerned primarily with a practical problem, and had, therefore, been directed to the compound in the form in which it is usually employed. The luminosity of the compound could be made more permanent while its intensity was diminished by reducing the radium content, and a sufficient reduction might conceivably lead to properties comparable with those of a uranium salt. The nature of the impurities to which Dr. Borns had referred was to some extent a trade secret. The report of the Chemical Research Board was a confidential document. Sir Ernest Rutherford had suggested that the "active centres" might be complex molecules, but the author did not himself hold any theory as to their nature.

Distortion of Resonance Curves of Electrically-driven Tuning Forks. By E. Mallett, D.Sc., M.I.E.E., A.M.I.C.E.

Abstract.

In the first section of the paper the experimental arrangements employed to obtain accurate resonance curves are described. In the second section resonance curves with increasing exciting currents show increasing distortion until an unstable state of affairs is arrived at in which the amplitude for a given current over a certain frequency range ca have two different values, depending upon whether the frequency has been approached from above or below. The indication here is that a decrease of resonant frequency takes place with increase of amplitude, and it further appears that an increase of damping also takes place. Experiments with a free fork show that these effects were still present, though not to the same extent as with the driven fork. Static experiments show a departure from the straight line law both in the case of the deflection of the fork prongs for given loads, and the flux change through the core for a given deflection of the prongs. In section 3 the effect of such departures on the equation of motion is considered mathematically; it is shown that the term depending on the cube of the amplitude is the most important and that its inclusion gives rise to resonance curves of the form observed. The effect of the static square terb is shown to be in effect a dynamic cube term. In section 4 the experimentally obtained resonance curves are examined in the light of the theory, and substantial agreement is found, while in section 5 a detailed calculation of the various constants is made. In section 6 another effect of the non-linearity mentioned is found in the possibility of producig fundamental frequency vibrations in the fork by means of exciting currents of double frequency, and the effect of a first harmonic in an exciting current of fundamental frequency is considered. In section 7 distortions of a second type are shown to consist of "coupled circuit" effects: these, at large amplitudes, are modified by distortions of the first type.

NOTICES OF BOOKS.

1914-1924 *Dix ans d'Efforts scientifiques, industriels et coloniaux*, sous la direction de M. Jean Gerard. Pp. 3,000. Paris: Chimie et Industrie, 49 rue des Mathurins. 1926. Price £2 8s.

The first volume of this important work was published some months ago. Its value and the vast amount of labour spent upon its production have been universally appreciated. It was divided into three parts. In a series of brilliant articles from the most eminent personalities in science and industry, it gave a complete account of the achievements during the years in question, from the technical as well as from the economic point of view.

Volume II., which has just appeared, has completed the compilations begun in the first part. It consists of three main sections. The first, entitled, "l'outillage économique de la France," is preceded by a preface from M. Yves de Trocquer, former Minister of Public Works, and is a review of France's progress in all the domains of economic activity.

The other two parts are concerned with France's colonial expansion. At a time when France is endeavouring to restore her financial position and when the cost of heavy imports weighs upon the trade balance this work has a special significance.

The last section, "l'outillage économique des Colonies," by M. Petre, France's Colonial Minister, constitutes the most complete account of the economic life of that country's possessions.

Inorganic Chemical Synonyms and Other Useful Chemical Data. By Elton R. Darling, Professor of Chemistry, James Millikin University, Illinois, U.S.A. Pp. VIII. + 120. New York: D. van Nostrand Company, 8, Warden Street, New York, U.S.A. Price 1 dollar.

Multum in parvo applies to this little book, which is well written and carefully arranged. The elements and their symbols and atomic weights, 1917, are given. Then follow the dates of the discovery of the different elements with the names of the discoverers, while a large space is devoted to the chemical synonyms. Special properties of the metals, with their atomic weights, specific gravity, specific heats, melting points, etc., are given in tabular alphabetical order, while there is given a cross index of chemical terms.

Quantitative Analysis. A Simple and Rapid Method (Also Clear Test). By F. Barker Smith, L.R.C.P. Price 1s., from the Author at his depot, 101, Holmdene Avenue, London, S.E.24.

Dr. Barker Smith is now a veteran, and as we have reason to know, he is essentially practical, so that it is not surprising that

he should produce a booklet of this kind which is intended for medical men, students, scientists, tutors and intelligent members of the public. He claims that with a few cheap and simple apparati an analysis can be made in a few minutes at a cost of a farthing. He claims that no laboratory is required and in fact, he claims to have standardised and simplified methods of analysis, gives numerous samples, and is prepared to teach readers how to carry out the various tests by his methods.

FORTHCOMING EVENTS.

GEOLOGICAL SOCIETY.

The next meeting of the Society will be held on Wednesday, June 15, at 5.30 p.m., when the following communications will be read :—

" The Structural Relations of the Mourne Granites (Ireland). " By J. E. Richey, M.C., B.A., F.R.S.E., F.G.S.

" The Stratigraphy of the Valentian Rocks of Shropshire : The Main Outcrop." By W. F. Whittard, Ph.D., B.Sc., D.I.C., F.G.S.

SOCIETY OF GLASS TECHNOLOGY.

The 100th Ordinary General Meeting of the Society will be held in the Applied Science Department, The University, St. George's Square, Sheffield, on Wednesday, June 15, 1927, at 2.30 p.m. The following papers will be read :—

" Gaseous Fuels for Furnace Heating". By R. Wigginton, B.Sc. (Department of Fuel Technology, The University, Sheffield.)

" The Thermal Expansion of some Boric Oxide Glasses and some Remarks on the Influence of the Inhomogeneity of the Glass." By Prof. W. E. S. Turner, and Francis Winks, M.Sc.Tech.

MINERALOGICAL SOCIETY.

Tuesday, June 14, at 5.30 p.m.—

A. F. Hallimond : " On the Atomic Volume Relations in Certain Isomorphous Series."

Dr. P. K. Ghosh : " Petrology of the Bodmin Moor Granite (Eastern Part)."

Prof. P. G. H. Boswell : " On the Distribution of Purple Zircon in British Sedimentary Rocks."

Dr. J. Drugman :" On β-Quartz Twins from Cornwall."

E. V. Holt and Dr. H. F. Harwood : " The Separation of Manganese in Rock Analysis."

Dr. L. J. Spencer : " Corundum Twins from Transvaal."

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

13,389.—Battig, R.—Production of hydrogen. May 18th.

13,272.—I. G. Farbenindustrie Akt.—Ges. —Process for absorbing ammonia, &c., from gases. May 17th.

13,650,—Evan, T.—Production of hydrocyanic acid from formamide. May 21st.

13,602.—I. G. Farbenindustrie Akt.—Ges. —Manufacture of complex metallic compounds of o-hydroxyazo dyestuffs. May 20th.

13,318-13,319.—Moore, J. W. —Manufacture of ammonium chloride. May 18th.

Specifications Published.

224,764.—Peterson, H.—Process of Manufacturing sulphuric acid.

246,142.—Buchner, M.—Cyclic process of producing soluble salts of organic compounds of an acid sharacter.

270,809.—British Celanese, Ltd., and Skertchley, W. P.—Purification of acetic anhydride.

270,820.—Parker Rust Proof Co.,—Process for the production of high-acid phosphates.

270,840.—I. G. Farbenindustrie Akt.—Ges. —Manufacture of anthraquinone derivatives.

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1/- each.

Abstract Published.

268,542.—Dyes.—British Dyestuffs Corporation, Ltd., 70, Spring Gardens, and Tatum, W. W., Crumpsall Vale Chemical Works, Blackley, both in Manchester.

1 - oxy - 2 sulpho-4-arylaminoanthraquinones, which are acid wool dyes and are described in Specification 21897/00, are obtained by the action of metallic sulphites on 1-oxy-2-halogen-4-arylaminoanthraquinones. In an example, 1 - oxy - 2 - chlor - 4 - tolyaminoanthraqinone (obtained by heating 1-oxy-2 : 4-dichloranthraquinone with *p*-toluidine) is dissolved in phenol and heated with sodium sulphite solution in an autoclave. The phenol is then steamed off and the product is salted out. It dyes wool from an acid bath in fast reddish-blue shades.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

TRUZONE.

479,635.—A chemical substance used in manufacture.—B. Laporte, Limited, The Chemical Works, Kingsway, Luton, Bedfordshire. May 25th.

OSCODAL.

480,078.—Chemical substances prepared for use in medicine and pharmacy.—H. A. Metz Laboratories Inc., 122, Hudson Street, City and State of New York, United States of America. May 25th.

ARTEROSAN.

480,058.—Chemical substances prepared for use in medicine and pharmacy.—Institut Sero-Therapique et Vaccinal Suisse Berne, Laupenstrasse 4a, Berne, Switzerland. May 25th.

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THE CHEMICAL NEWS

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THE STRUCTURE OF AN ATOM OF NITROGEN. III.

By HAWKSWORTH COLLINS, B.A. (Camb.).

In the *Chemical News*, 1927, cxxxiv., 209, the publication of this investigation was commenced and in the same, 1927, cxxxiv., 273, one of the seven distinct forms of nitrogen was fully demonstrated. The present paper is concerned solely with another of the seven forms, whose relative volume is 16.02 at 15° C., when it takes part in the formation of a solid or liquid compound. Its heat of formation in the solid, liquid and aqueous states is − 54014. Its M.R. is 0.437 and O.R. 3.8. When a solid or liquid substance containing it is raised to the gaseous state and put through the process of combustion, its heat of combustion is zero, and therefore its H.F. is also zero. This fact denotes that the atom of N passes from its position in the gaseous compound into its elementary state without any alteration of volume; but it does not follow that its volume in the gaseous state is 16.02.

When this investigation with regard to N is completed, it will be necessary to demonstrate the relative volumes, H.C., H.F., M.R., O.R., etc., of the atoms of C and H in simple chain, iso-, secondary, tertiary, allyl and benzene compounds. At present these particular matters can only be partially demonstrated. Meanwhile it is necessary to remember that whenever the facts with regard to one series of constants correspond (as given in the last column of the Tables) with another series of constants, there is no possibility of error; *i.e.*, the matter is proved to be true. In addition to this the constants are frequently in accordance with the laws of relative volume, of heat of formation, or of magnetic rotation.

TABLE XIV.

THE RELATIVE VOLUME OF NITROGEN, 16.02.

	Relative Volume.	Theor. S.G. at 15° C.	Obs. S.G.		Corresponds with Nos.
(1)	$C_3H_7NO_2$ 61.48 + 16.02 + 2(7.53)	0.96	0.935	21° Cahours	99
			1.011	Perkins	106
	(where 61.48 = 12.22 + 3 × 16.42)				
(2)	$C_3H_7NO_2$ 64.51 + 16.02 + 2(7.53)	0.931	0.935	21° Cahours	100
	(where 64.51 = 15.25 + 3 × 16.42)				
(3)	$C_2H_5NO_2$ 48.09 + 16.02 + 2(7.53)	0.947	0.947	15° Liebig	
	(where 48.09 = 15.25 + 2 × 16.42)				

(4)	$EtNO_2$ + $AmNO_2$ 48.09 + 16.02 + 2(7.53) + 23.87 + 16.02 + 2(2.51)	1.12	1.12	30° Ray	
	(where 23.87 = 0.86 + 4 × 5.76)				
(5)	$AgNO_2$ 13.29 + 16.02 + 2(2.51)	4.457	4.453	25° Nostrand	
(6)	AgI 13.29 + 27.75	5.702	5.707	Eamour	
(7)	BiI_3 21.29 + 3(27.75)	5.641	5.64 - 5.65	20° Gott	
(8)	Bi 21.29	9.82	9.82	Roberts	
(9)	p.$Cl.C_6H_4.NO_2$ 23.01 + 59.2 + 16.02 + 2(2.51)	1.525	1.520	18° Nostrand	
(10)	$Cl_3C.NO_2$ 3(23.01) + 8 + 16.02 + 2(2.51)	1.68	1.66	19° Nostrand	
(11)	Et. isocyanide 48.09 + 8 + 16.02	0.763	0.759	4° Nostrand	94
			0.787	15° Pelouze	52, 57
(12)	Isopr.NC 66.78 + 16.02 + 8	0.7599	0.7596	0° Gautier	
(13)	Isopr.Cl 66.78 + 23.01	0.874	0.874	10° Linnemann	
(14)	$C_6H_5.CN$ 77.48 + 8 + 16.02	1.01	1.01	17° Kopp	96
(15)	C_6H_5Br 77.48 + 27.0	1.493	1.492	22°/4 Int.	
(16)	KCN 18.637 + 8 + 16.02	1.52	1.52	12° Bodeker	72, 75
(17)	K_2SO_4 2(18.637) + 35.61	2.4	2.400	Jacquelin	
(18)	$Cl.CH_2.CN$ 23.01 + 16.42 + 8 + 16.02	1.19	1.193	20° Engler	
(19)	HgC_2N_2 16.60 + 2(8 + 16.02)	3.88	3.77	13° Bodeker	
			3.990	Schroder	
(20)	HgI_2 (red) 16.60 + 2(27.75)	6.29	6.29	20°/20 Nostrand	
(21)	AgCN 9.78 + 8 + 16.02	3.94	3.95	Nostrand	
(22)	Ag_4Sn 4(9.78) + 16.02	9.9	9.95	15° Holzmann	
(23)	$AgSn_6$ 9.78 + 6(16.02)	7.69	7.666	18° Holzmann	
(24)	CNCl 8 + 16.02 + 23.01	1.31	1.32	Nostrand	
			1.222	0° Nostrand	
(25)	m.Tolunitril, $CH_3.C_6H_4.CN$ 31.67 + 62.23 + 8 + 16.02	0.992	0.984	25°/25 Kahlbaum *i.e.*, 0.992 15°	
(26)	$C_6H_5.CH_2.CN$ 74.45 + 16.42 + 8 16.02	1.018	1.016	20°/4 Nostrand	
(27)	$C_6H_5.CO_2$ Et 74.45 + 66.13	1.067	1.06	18° Delffs	
(28)	$CN.CH_2.CO_2Et$ 8 + 16.02 + 16.42 + 66.13	1.06	1.06	25°/25 Nostrand	
(29)	$C_3H_5.NCS$ 58.29 + 16.02 + 8 + 15.53	1.012	1.0173	10° Nostrand	
			1.010	15° Will	101
	where 58.29 = 2(0.71) + 2(15.25) + 9.95 + 16.42				
(29A)	$C_3H_7.NCS$ 64.51 + 16.02 + 8 + 15.53	0.971	0.991	0° Nostrand *i.e.*, 0.978 15°	104
(30)	$C_3H_5.I$ 58.29 + 32.77	1.845	1.846	15° Romburgh	
			1.839	14° Linnemann	
(31)	Tert.but. NCS 83.2 + 16.02 + 8 + 15.53	0.937	0.949	10° Chem. Kal.	
			0.919	15° Rudneff	105
(32)	Tert.but.I 83.2 + 32.77	1.586	1.587	0° Puchot	
(33)	Thiocyanacetone $CH_3.CO.CH_2.NCS$ 28.64 + 8 + 4.45 + 16.42 + 16.02 + 8 + 15.53	1.19	1.195	20° Tcherniak	
(34)	Acetone $CH_3.CO.$ CH_3 28.64 + 8 + 4.45 + 16.42 + 15.25	0.797	0.797	15° Linnemann	
(35)	AmCNS 19.08 + 8 + 16.02 + 15.53	1.297	1.299	13° Dudley i.e., 1.297 15°	68
	(where 19.08 = 0.83 + 0.97 + 3(5.76))				
(36)	AmCl 19.08 + 15.085	1.57	1.578	Playfair	
			1.522	Schiff	

(37)	AmBr 19.08 + 23.09	2.324	2.327	Eder	
(38)	CH_3.SCN 28.64 + 15.53 + 8 + 16.02	1.07	1.07	4° Nasini	
			1.07	24°/4 Nostrand	
(39)	C_2H_5.SCN 48.09 + 15.53 + 8 + 16.02	0.993	0.995	4° Nasini	
			1.007	4° Nasini	
(40)	Hexyl SCN 116.04 + 15.53 + 8 + 16.02	0.919	0.922	12° Pelouze *i.e.*, 0.919 15°	
(41)	H exyl I 116.04 + 32.77	1.43	1.43	19° Pelouze	
(42)	$Cl(CH_2)_2$ SCN 23.01 + 2(16.42) + 15.53 + 8 + 16.02	1.274	1.28	15° James	
(43)	$PbC_2N_2S_2$ 19.81 + 2(0.71 + 2(16.02) + 2(15.53)	3.82	3.82	Nostrand	90
(44)	$PbCO_3$ 19.81 + 8 + 7.53 + 2(2.51)	6.59	6.60	Smith	
			6.5	John	
(45)	KCNS 18.637 + 0.71 + 16.02 + 15.53	1.905	1.908	14° Bodeker	73, 61
			1.906	Nostrand	
(46)	KCNO 18.637 + 0.71 + 16.02 + 4.45	2.035	2.056	4° Schroder	
			2.048	Nostrand	71, 74
(47)	$K_6Cr(CNS)_{12}.8H_2O$ 6(18.05) + 21.73 + 12(8 + 16.02 + 10.51) + 8(14.03)	1.71	1.71	16° Dudley	
(48)	K_2S 2(18.05) + 15.53	2.130	2.130	Filhol	
(49)	KF 18.05 + 5.42	2.471	2.476	Schroder	
(49A)	Cr_2Cl_6 *2(21.73) + 6(15.085)*	*2.36*	*2.36*	*Chem. Kal.*	
(49B)	As_2S_2 2(19.58) + 2(10.51)	3.556	3.556	Mohs	
(49C)	As_2S_3 2(19.58) + 3(10.51)	3.48	3.48	Haidinger	

TABLE XV.

HEAT OF COMBUSTION OF THIS FORM OF N (GAS) IS ZERO.

	Heat of Combustion.		Theor.	Obs.		Corresponds with
(50)	$C_2.N_2$ 2(128496) + 2(0)	=	256992	259620	T	
(51)	$C.H_3.N.C$ 27100 + 157787 + 0 + 128496	=	313383	312140	T	56
(52)	$C_2.H_5.N.C$ 27100 + 2(157787) + 0 + 128496	=	471170	471450	T	11, 57, 94
(53)	H.C.N. 27853 + 128496 + 0	=	156349	158620	T	58
(54)	$C.H_3.S.C.N.$ 27100 + 157787 + 86429 + 104218 + 23630	=	399164	398950	T	59

(157787 is explained in Table XX.)

TABLE XVI.

HEAT OF FORMATION (GAS).

			Calculated by Collins	Calculated by Thomsen and others	Corres-ponds with
(55)	$C_2.N_2$. - 2(32078) + 2(0)	=	-64156	-65700	50
	also 2(96418) + 2(0) - 256992	=	-64156		
(56)	$C.H_3.N.C.$ 7280 + 7391 + 0 - 32078	=	-17407	-16260	51
	also 2(96418) + 3(34380) - 313383	=	-17407		
(57)	$C_2.H_5.N.C.$ 7280 + 2(7391) + 0 - 32078	=	-10016	-9670 to -10830	52, 11, 94
	also 3(96418 + 5(34380) - 471170	=	-10016		

(58)	H.C.N. 6527 − 32078 + 0	=	−25551	−27150	53
	also 34380 + 9§418 + 0 − 156349	=	−25551		
(59)	C.H$_3$.S.C.N. 7280 + 7391 − 15530				
	− 7800 − 23630	=	−32289	−31990	54
	also 2(96418) + 3(34380) + 70899				
	− 399164	=	−32289		

TABLE XVII.

HEAT OF FORMATION (AQUEOUS AND SOLID), − 54014

			Calculated by Collins	Calculated by Thomsen and others	Corresponds with
(61)	K.C.N.S.aq. 50324 + 48014 −				
	− 54014 + 0	=	44324	43700	45, 73
(62)	K$_4$.Fe.C$_6$.N$_6$ 4(50324) − 27787 +				
	6(48014) − 6(54014)	=	137509	137200	
(63)	Fe. Br$_2$.aq. − 27787 + 2(52930)	=	78073	78070	
(64)	Fe.Cl$_2$.aq. − 27787 + 2(63870)	=	99950	99950	
(65)	H.C.N. − 15300 + 48014 − 54014	=	−21300	−21300	
(66)	Na.C.N.aq. 31234 + 48014 − 54014	=	25234	25450	80
(67)	Na.F.aq. 31234 + 77500	=	108734	108700	
(68)	N.H.$_4$.C.N.S.aq. 19610 + 48014 −				
	54014 + 0	=	13610	15030	35
(69)	N.H.$_4$.Cl 19610 + 56786	=	76396	76800	
(70)	N.H$_4$.Br 19610 + 45244	=	64854	65350	
(71)	K.C.N.O.aq. 33228 + 48014 −				
	54014 + 71515	=		100650	
			98743	97300	46, 74
(72)	K.C.N.aq. 33228 + 48014 − 54014	=	27228	27200	16, 75
(73)	K.C.N.S 50324 + 48014 − 54014 +				
	6217	=	50541	49800	45, 61
(74)	K.C.N.O. 37274 + 48014 − 54014 +				
	71515	=	102789	102500	
				105850	71, 46
(75)	K.C.N. 37274 + 48014 − 54014	=	31274	30100	
				33450	16, 72
(76)	Hg.C$_2$.N$_2$ − 46590 + 2(48014) −				
	2(54014)	=	−58590	−59150	
(77)	Hg.I$_2$ − 46590 + 2(36226)	=	25862	25640	
(78)	N.H.$_4$.C.N − 23630 + 4(8005) +				
	48014 − 54014	=	2390	2300	
(79)	N.H$_4$.Cl.aq. − 23630 − 4(8005) +				
	63870	=	72260	72800	
(80)	Na.C.N 32747 + 48014 − 54014	=	26747	25950	66
(81)	NaI 32747 + 36226	=	68973	69080	
(82)	Cu.C.N − 15500 + 48014 − 45014	=	−21500	−20235	
				−22050	
(83)	Cu$_2$.O −2(15500) + 71515	=	40515	40810	
(84)	Ca.C$_2$.N$_2$ 53376 + 2(48014) −				
	2(54014)	=	41376	41650	
(85)	Ca.O 53376 + 96155	=	149531	151900	
(86)	Fe$_7$.C$_{18}$.N$_{18}$ − 7(21101) + 18(48014)				
	− 18(54014)	=	−255707	−256700	
(87)	H$_4$.Fe.C$_6$.N$_6$ − 4(15300) − 21101				
	+ 6(48014) − 6(54014)	=	−118301	−122000	
(88)	Fe$_2$.O$_3$ − 2(21101) + 2(71515)				
	+ 96155	=	196983	197700	
				195000	

(89)	$N.H._4.C.N.S$ 19610 + 48014 - 54014 + 6217	= 19827	20700		
(90)	$Pb.C_2.N_2.S_2$ -40607 + 2(48014) - 2(54014) + 2(30681)	= 8755	6100		43
(91)	$Pb.C.O_3$ -40607 - 13855 + 32341 + 2(96155)	= 170189	170000		
(92)	Ca.S 64420 + 30681	= 95101	94300		
(93)	Ca.O 64420 + 96155	= 160575	160000		

19610 (NH_4) = -20500 + 16095 + 3(8005)

TABLE XVIII.

MAGNETIC ROTATION OF NITROGEN, 0.437.

		Theor.	Obs.	Corresponds with
(94)	C_2H_5NC 0.235 + 2(1.023) + 0.437 + 0.633	= 3.351	3.322 to 3.341	57, 11, 52
(95)	C_2H_5I 0.235 + 2(1.023) + 7.778	= 10.059	10.040 to 10.105	
(96)	C_6H_5CN 10.707 + 0.633 + 0.437	= 11.775	11.857	14
(97)	Phenyl oenanthate, $C_6H_5CO_2C_6H_{13}$ 10.705 + 0.633 + 0.042 + 0.202 + 6(1.023) + 0.235	= 17.955	17.923	
(98)	Et. propionate, $C_2H_5CO_2C_2H_5$ 2.281 + 0.877 + 2.281	= 5.439	5.440 to 5.466	
	where 2.281 = 0.235 + 2(1.023)			
(99)	$C_3H_7NO_2$ 0.265 + 3(1.023) + 0.437 + 2(0.042)	= 3.855	3.782 to 3.849	1, 106
(100)	$C_3H_7NO_2$ 0.235 + 3(1.023) + 0.437 + 2(0.042)	= 3.825	3.782 to 3.849	2

TABLE XIX.

OPTICAL REFRACTIVITY OF NITROGEN, 3.8

		Theor.	Obs.	Corresponds with
(101)	C_3H_5NCS 14.3745 + 3.8 + 3.333 + 8.67	= 30.1775	30.43 M_D *i.e.*, 30.28 M_α	29
	where 14.3745 = 6.666 + 2(0.985) + 1.125 + 4.6135.			
(102)	$C_3H_5NH.CS.NH_2$ 14.3745 + 3.8 + 0.82 + 3.333 + 8.67 + 4.438	= 35.4355	35.44, 78°	
	where 4.438 = 2.493 + 1.125 + 0.82			
(103)	$C_4H_7NH.CS.NH_2$ 35.4355 + 4.6135	= 40.049	40.19	
(104)	C_3H_7NCS 0.985 + 3(4.6135) + 3.8 + 3.333 + 8.67	= 30.6285	30.84 M_D i.e., 30.69 M_α	29A
(105)	Tert.C_4H_9NCS 30.6285 + 4.6135	= 35.242	35.17 M_D	31
(106)	$C_3H_7NO_2$ 1.125 + 3(4.6135) + 3.8 + 2(1.654)	= 22.0735	22.10	1, 99

The atom of carbon whose Heat of Formation is 48914 in Nos. 61—90 must have been obtained from a form of carbon whose S.G. is 2.09, and therefore whose relative volume is 5.74 (= 12 ÷ 2.09).

S.G. 2.08 Baudrimont (gas carbon)

S.G. 2.10 Scholz (charcoal from alcohol)

48014 = 795 × 5.03 × 12 and 5.74 = 0.71 + 5.03, so that the change of volume is 5.03, *i.e.*, its volume (5.74)in the free state becomes 0.71 in the combined state.

The relative volume of the group CH_2 which appears in thousands of substances is 16.42, and its other constants are as shown in the following Table.

TABLE XX.
CONSTANTS OF THE GROUP CH_2 AT 15° C.

	CH_2	=	C	+	H	+	H
Relative Volume	16.42	=	0.71	+	9.95	+	5.76
Heat of Combustion	157787	=	104218	+	27194	+	26375
Heat of Formation	7391	=	-7800	+	7186	+	8005
Magnetic Rotation	1.023	=	0.459	+	0.165	+	0.399
Optical Refractivity	4.6135	=	2.6685	+	1.125	+	0.82

Each one of the above constants has been fixed in many ways; but there is no room here to demonstrate the matter fully.

This paper cannot be followed satisfactorily without reference to the Tables of Constants in the *Chemical News*, 1927, cxxxiv., 209 The Optical Refractivity of S (15.53) should have been given there as 8.67 instead of 8.0.

General Notes.

HONOUR FOR PROFESSOR F. G. DONNAN.

Prof. F. G. Donnan, C.B.E., F.R.S., has been elected a member of the Royal Academy of Sciences of Amsterdam, this fills the vacancy caused by the death of Professor Jolgi.

ESTONIA PROGRESSING.

For the first time in the history of the young Republic the foreign trade of Estonia showed a favourable balance in 1295, writes Mr. H. Montgomery Grove, British Consul-General at Reval, in a report covering the past two years, There was a smaller total trade in 1926, but the excess of exports was considerably larger. Imports from Great Britain are much less than they should be in many directions, which are pointed out.

FRENCH IMPORTS IN 1297.

Imports into France during the first four months of the year were of less value from Great Britain, Italy, Brazil and the United States than in the corresponding period of 1926, but of larger value from Germany, Canada, Holland, Poland and Spain. French exports to Great Britain and Germany, among other countries, showed an increase, but to Belgium and Italy, among others, a decrease.

NEW CAPITAL ISSUES.

According to Midland Bank statistics issues of new capital in the United Kingdom in May amounted to £34½ millions, bringing the total for 1927 to nearly £139¾ millions is against less than £102½ millions in January-May 1926.

WHOLESALE PRICES IN MAY.

As registered at the Board of Trade, wholesale prices in May averaged 0.8 per cent. more than in April, the index numbers for the two months being 84.9 and 84.2 respectively (1924—100). A higher index is shown for each of the three groups relating to food, cereals becoming dearer by 4.0 per cent., the group of miscellaneous foods by 4.6 per cent., and meat and fish by 0.5 per cent. The general average for industrial materials was lower by 0.2 per cent., in May as compared witht April, the rise in the price of cotton (6.6 per cent.) and of miscellaneous industrial materials (0.3 per cent.) being more than counter-balanced by the reductions in the cases of iron and steel (1.8 per cent.), othere metals and minerals (3.7 per cent.), and textiles other than cotton (1.1 per cent.)

LIME AND LIME MORTARS.*

The purpose of the recently issued report on Lime and Lime Mortars is to give an account of the various uses of lime (quick-lime and slaked or hydrated lime) in building operations, to give a practical classification of the different types of limes, and to indicate for which uses they are best adapted; to collect together the many valuable hints and suggestions offered by traditional practices in the craft, in which the literature of the subject abounds; and to provide a useful bibliography of references to accessible works for those who are sufficiently interested in particular points to wish to follow them up further. Detailed definitions and specifications of different lime products (and immediately related materials used in lime mortar and plaster) are then developed from the con-

siderations brought forward here, and with due reference to such tentative or standard specifications as have already been prepared by different public bodies for lime products, gypsum plasters, and Portland cement.

* Building Research Special Report No. 9, of the Department of Scientific and Industrial Research. Published by H.M. Stationery Office. Price 1s. 9d. nett.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act, 1920.

The following statement relating to applications for licenses under the Dyestuffs (Import Regulation) Act, 1920, made during May, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applicants received during the month was 656, of which 542 were from merchants or importers. To these should be added 29 cases outstanding on the 30 April, making a total for the month of 685.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE FARADAY SOCIETY.

The following paper was read at the meeting held on May 25, 1927 :—

The Action of Iron as an Impurity in the Lead Accumulator. Part I. Capacity Loss Due to Self-Discharge. By Frederick Measham Lea and John Teare Crennell.

Introductory.

Iron has generally been considered as a serious impurity in the lead accumulator, but until recently little definite evidence of its action has been forthcoming.

Dolezalek has proposed the theory that metals capable of existing in more than one valency stage in the electrolyte, and lying above lead in the electromotive series, causes a loss of capacity in a cell by undergoing repeated cycles of oxidation at the positive plate and of reduction at the negative plate. Parr and Vicarey stated that iron has serious effects on the lead accumulator, but advanced little definite evidence regarding the nature of its action. Gillette carried out "poisoning" experiments on lead cells with various impurities, including iron, but did not examine the actions occurring. Vinal and Altrup studied the effect of iron on the rates of sulphation of positive and negative plates by a weighing method. The increase in weight of a positive plate immersed in a sulphuric acid solution containing ferrous iron, as compared with a similar plate in a pure acid, was found to be in agreement with that required by the equation,

$$PbO_2 + 2FeSO_4 + 2H_2SO_4 \longrightarrow PbSO_4 + Fe_2(SO_4)_3 + 2H_2O$$

this being the normal self-discharge equation for the positive plate according to the Dolezalek theory. The introduction of a negative plate into a solution containing a potitive plate which had come to equilibrium with its solution, *i.e.*, when the equation was complete, was found to lead to a further increase in the positive plate weight, showing that reaction was recommencing owing to the reduction of ferric to re-oxidation, according to the equation at the positive plate. The action at the negative plate was represented by the two equations,

$$Pb + Fe_2(SO_4)_3 \longrightarrow PbSO_4 + 2FeSO_4$$
$$Pb + H_2SO_4 \longrightarrow PbSO_4 + H_2$$

The weight increases for a negative plate immersed in a sulphuric acid solution of ferric sulphate, compared with a plate in pure acid, were found to be in excess of the amount calculated by equation. This was interpreted by Vinal and Altrup as indicating that the presence of iron accelerates the action, but this accelerating action was found to be greatest in the initial stages and to die out after equation had come to equilibrium (about 150 hours). It was calculated that the velocity of the reaction had been increased, during the pre-equilibrium period ,about 7 and 3 times for solutions containing 0.08 per cent. and 0.012 per cent. respectively. These actual figures appear to be due to an error in calculation, the correct values, from the data given, being 3.77 and 1.35. This acceleration of reaction has not been confirmed in the present investigation. The results of these workers constitute proof of the accuracy of the Dolezalek theory, but do not give any quantitative data concerning the actual rates of capacity loss in a complete cell.

General Outline of the Investigation.

The method employed in this work has been the "poisoning" of cells by introducing known amounts of iron into the electrolyte. Experiments of a semi-quantitative nature were carried out initially, at laboratory temperatures by selecting groups of four cells of equal capacity, as

determined by a long series of preliminary cycles of charge and discharge, and introducing iron into the cells so that in any one group the iron concentrations in the electrolyte were 0.1, 0.01, 0.001, and zero, gms. of iron per 100 c.c. (In actual practice the "zero" cell always contained some iron derived from the cell materials which was not completely removable by changing the electrolyte.) Such groups exhibited two types of capacity loss proportional to the iron concentration in a cell.

A cell containing iron when discharged after various periods of standing was found, compared with a cell with pure electrolyte, to show a loss of capacity increasing with time. This loss is termed the "Self-discharge" loss and is due to the action of the iron as suggested by the Dolezalek theory.

A cell containing iron, if discharged immediately after charge, exhibited a loss of capacity compared with a cell containing pure electrolyte. This loss is termed the "Permanent" loss as it has been shown that it cannot be due to self-discharge during the period required for discharge.

Similar groups of cells were permitted to stand in a discharged condition for periods up to 36 days, to determine if iron had any effect on the so-called "sulphation" produced in a load cell when standing discharged. These cells were then charged and immediately discharged. A loss of capacity of type was observed in cells containing iron, equal in magnitude to that observed in the previous experiments, but otherwise these cells gave their normal capacities, showing that such "sulphation" was neither influenced by the presence of iron nor actually occurring. In order to determine that no other effects were occurring, two groups, each of four cells, were charged and discharged on alternate days at the normal rates (5 to 7 hour rates). Two further groups were discharged at the one hour rate and recharged at the normal rate on the same day. In neither case was any effect on the life of the cells observed. The cells discharged at the one hour rate all showed marked loss of capacity, due to loss of positive paste, after nearly 200 cycles, but no relation between the iron content and this loss was found, while after about 75 cycles those discharged at the normal rate showed no deterioration for any iron content.

A close check was kept on the electrolyte iron concentrations of all cells. It was found that the iron tends to become unequally distributed throughout the electrolyte of a cell, the concentration increasing towards the bottom. In addition the iron is adsorbed by the positive paste (lead-peroxide), and the resulting equilibrium is dependent on a number of factors. This adsorption has been found to be related to the Permanent loss occurring in a cell containing iron, and for convenience the discussion of these effects has been deferred to the second paper.

SUMMARY.

The relations between the permanent loss occurring in a cell containing iron and the adsorption of iron by the positive paste have been studied.

The permanent loss has been measured for a series of temperatures, iron concentrations, and discharge rates.

The adsorption of iron by the positive paste increases with decreasing acid concentration and also with increase of temperature. This adsorption has been attributed to the presence of a hydrolysis product of ferric sulphate. The adsorption by the lead peroxide is to a large extent irreversible, but desorption is produced by the electrical working of cells in which the paste and electrolyte iron concentrations are not in equilibrium.

The permanent loss and the adsorbed iron concentration are connected by an approximately linear relation. The permanent loss is recovered by an approximately linear relation. The permanent loss is recovered by the renewal of electrolyte in proportion as the iron concentration is reduced.

Both sulphuric acid and ferric sulphate are adsorbed by lead peroxide, but the latter is adsorbed more strongly. The permanent loss has been attributed to this preferential adsorption of the iron and a theory of the action suggested.

SOCIETY OF GLASS TECHNOLOGY.

Meetings of the Society of Glass Technology were held in University College, London, on Wednesday, May 18 and on Thursday, May 19, 1927, the President, Mr. W. Butterworth Senr., M.A., in the chair.

On the evening of May 18, the Annual Dinner was held in the Hotel Cecil, London, and during the morning of May 19, a visit took place to the Lamp Works of the General Electric Co., Ltd., at Brook Green, Hammersmith.

At the meeting on the afternoon of May 18, the following three papers were presented :—

The Decomposition of Glass by Water at High Temperatures and Pressures. By DR. G. W. MOREY AND DR. N. L. BOWEN.

The glasses were heated with water in steel bombs for about 20 hours. The bomb was then cooled and the product examined. In the case of optical glasses it was found that the barium glasses presented a consistent picture. The amount of attack was greatest with a light barium crown, and least with the very dense barium crowns which were remarkably resistant. The lead glasses as a whole showed a consistent and interesting relation between composition and resistivity. With small PbO content, as in the "soft crowns" of extra light flints, the glasses were badly decomposed at 300° C. and practically complete at 550°. As the lead content was increased, the glasses rapidly improved, the extra dense flints showing remarkable resistance towards water. Of all the glasses tested, a high lead glass was the most resistant to the action of water under the extreme conditions tested.

In addition to the optical glasses, a number of commercial glasses, in the form of pieces of tubing, were subjected to a similar treatment, at the same temperatures. Jena combustion tubing withstood the action of water best, whilst the failure of Pyrex glass was outstanding. At lower temperatures the Pyrex glass was exceedingly good, but at the higher temperatures of the experiments the boric oxide was completely extracted. The crystals obtained with Pyrex glass at 325° were unknown but were of particular interest, and their composition was being studied.

The Brittleness of Opal Glass. By PROF. DR. G. GEHLHOFF AND DR. M. THOMAS.

For the determination of the impact strength a special apparatus was described; and Winkelmann and Schott's method was modified by using pressed balls instead of ground and polished cubes. A dense opal glass containing much fluoride was used, the opacity being increased by the addition of zinc oxide. It was found that at a temperature of about 1,040° C. some discontinuous changes took place, possibly explainable in the following way. At high temperatures the opal glass was clear. In cooling down, crystals of a uniform and small size of grain were precipitated. The glass kept below the devitrification temperature already contained (owing to its having stood longer) bigger crystals. On further cooling down in conformity with the law of the yet undefined constitution diagram, small crystals were precipitated, whereas the existing big ones still grew. It might appear feasible that the opal-glass, containing only crystals of a uniform and small size, possessed greater mechanical strength than a glass consisting of crystals of various sizes, particularly larger ones. The investigation showed that opal glasses must necessarily be worked above the temperature where precipitation of crystals caused opacity of the glass. It was suspected (from work being done) that similar phenomena held good in respect of clear glass.

The New British 15-Arm Automatic Sustion Bottle Machine. By FRANCIS REDFERN, JNR.

This machine is composed of 15 separate bottle-making units, each complete in itself. All the important bearings on the machine are Tinken roller bearings or ball bearings, totally enclosed and dirt-proof. There are approximately 40 tons of moving parts mounted on the stationary element, and the whole machine weighs about 60 tons. It will revolve up to speeds of between 6 and 7 revolutions a minute, and is electrically controlled. By means of an electro-magnetic brake automatically applied, it can be brought to rest from a speed of 6 revolutions a minute within 2½ feet. To accommodate the machine to the level of the pot, or the glass in it, it is raised or lowered by a small motor which is cut out automatically at the highest and lowest positions. At 6 revolutions a minute, the machine takes about 11 horse-power to revolve it. The machine is constructed in such a way that it is possible to sit inside it while it works. The range in length of bottles (measured from the bottom to the parting line below the ring) which can be manufactured on the machine is from 15 inches to 2½ inches, for a maximum diameter of blow mould of 9 inches and of parison moulds of 7 inches. Wide mouth ware can be made in which the maximum outside diameter of the neck mould is 5¼ inches, and the maximum length of plunger which can be inserted into the bottle is 2⅝ inches. A week's production of merchantable reputed quart bottles is estimated at 2,800 gross.

The machine can be produced in three sizes, 6 units, 10 units, and 15 units. For bottle makers whose trade is of a miscellaneous character, it is claimed that a machine of this design would be ideal. It was possible to make on it, at one and the same time, 6 different bottles all of different shapes, varying in height within a

difference of $3\frac{1}{2}$ inches. Bottles varying in weight by 4 ozs. have been made on a 10-arm machine.

The Meeting on the afternoon of May 19, was devoted to a discussion of "Furnace Efficiency." The discussion was opened by Prof. W. E. S. Turner, who gave a *résumé* of the paper he had presented at the April meeting, namely, "A Brief Review of Furnace Developments."

Mr. M. P. Dudding and Mr. E. A. Coad-Pryor suggested that the discussion be focussed under the following headings:—(a) Load-Fuel Consumption; (b) Age of Tank; (c) Load and Effect on Total Life; (d) Maximum Efficient Load; (e) Composition of the Glass; (f) External Conditions of all Kinds such as Contour of Neighbouring County, Prevailing Wind, etc.; (g) General Design—Ports, Bridges, Melting Areas, etc.

At the suggestion of Mr. J. H. Webster, a further heading was added, namely (h) The Method of Control of Gas and Air.

Mr. J. H. Webster observed that too many pot furnaces and tanks suffered from insufficient control. It was quite a common thing to find neither gas nor air control. The question of the number of Dog Holes was under consideration. He had seen tanks with as many as four, and the introduction of four was an easy proportion and could assist in overcoming those imaginary currents which were said to be set up in tanks having one dog hole. With regard to heat losses these were discovered at three important places, (1) Producer, 17 per cent.; (2) Furnace structure, 40 per cent.; and (3) chimney flues, 28 per cent. Fifteen per cent. seemed to be the best figure obtained for heat utilised in actual practice. Reference was also made to waste heat boilers and to powdered fuel.

Other members also spoke.

GEOLOGICAL SOCIETY.

The following papers were read at the meeting held on January 5, Dr. F. A. Bather, M.A., F.R.S., presiding:—

The Nature and Origin of Soil-Polygons in Spitsbergen. By Charles S. Elton. Communicated by Dr. J. A. Douglas, M.A., Sec.G.S.

Observations and excavations in the north of Spitsbergen have made it necessary to revise the classification of the various types of soil-polygons found in that country. New suggestions are also made as to the way in which they formed. Polygonal soils are divided primarily into mud-polygons and stone-polygons. The mud-polygons are formed in two quite different ways; there are larger ones produced by frost-expansion of the soil in winter, and smaller ones formed by drying of the soil in summer. In the latter season both are usually found together. Stone-polygons are more difficult to explain. and there are probably several factors at work. A new factor is described in this paper, which acts in the following way:—mixed materials, consisting of rocks, gravel, and mud, become differentially arranged in a vertical direction, so that there is mud below, grading into stones on the surface. The mud freezes in winter, expands, and forms regular mud-polygons, invisible from the surface at that stage. Later, as the overlying stones become disintegrated, the centres of the mud-polygons reach the surface, and when they freeze in winter exert a lateral pressure forcing the stones outwards, forming at first, rings, and later, stone networks. This explanation of the origin of stone-polygons is confirmed by a series of excavations of various stages in the process, beginning with weathering rock-detritus, and ending with stone-polygons.

Finally, evidence is given of the importance of plants, in stabilising the surface-soil in Arctic regions.

A discussion followed in which Prof. J. W. Gregory, Mr. H. Dewey and Mr. S. Hazeldine Warren, took part.

The Tertiary and Post-Tertiary Lacustrine Sediments of the Nyasan Rift-Valley. By Frank Dixey, D.Sc., F.G.S. (Read by Dr. John Parkinson, M.A., F.G.S.

The series of lacustrine sediments extending along the north-western shores of Lake Nyasa, formerly thought to be of recent age, are now known to include the Deinosaur-Beds of late Jurassic or early Cretaceous age, as well as the following six groups of beds that range through Tertiary and post-Tertiary times:—

(6) Recent deposits.	Recent.
(5) The Dwangwa Gravels	
(4) The Songwe Volcanic Rocks	Pleistocene.
(3) The Chitimwe Beds	
(2) The Chiwondo Beds	Pliocene.
(1) The Sungwa Beds	?Miocene.

These sediments extend over an area 78 miles in maximum width, and they occupy the floors of several minor rifts that run parallel with the main rift-valley. The

beds extend increasingly farther inland according to their age, and the oldest group the Sungwa Beds) rises to a height of 1,000 feet above the present level of the lake. The different groups rest upon the worn edges of the Deinosaur-Beds and all older rocks, and they are themselves separated by a series of unconformities; moreover, the sediments all dip towards the floor of the main rift, and each group is inclined in this direction at a steeper angle than that of the group immediately overlying it. These observations are of considerable interest in connection with the structure of the main rift-valley, as well as with the development of Lake Nyasa itself.

The Sungwa Beds consist of thickly bedded sandstones and conglomerates, of which only a few small patches remain.

The Chiwondo Beds comprise a thick series of calcareous sands, marls, and limestones; they have yielded remains of *Mastodon* and of *Hippopotamus*, as well as a number of associated fossil shells.

The Chitimwe Beds consist of red conglomerates and gravels that usually form a strong battlemented capping to the outcrops of the Chiwondo Beds.

The Songwe Volcanic Rocks comprise variable tuffs and ashes; they occur only at the northern end of the lake.

The Dwangwa Gravels may be traced almost all around the lake at a maximum height of 400 feet.

The recent deposits include the youngest lacustrine sediments, up to a height of about 160 feet above lake-level.

A discussion followed.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The following paper was read at the meeting on Tuesday, May 10, 1927 :—

The Burning of Mineral Oils in Wick-Fed Lamps. By J. Kewley, M.A., F.I.C., and J. S. Jackson, B.Sc., A.I.C. (Members).

The development of methods of artificial lighting is by no means the least of the achievements of the nineteenth century. It is hard to realise that prior to a time within the memory of living men the only methods of illumination available were little in advance of those employed in the days of the Greek and Roman Empires. The earliest known means of providing artificial light was probably the torch. This must have been superseded at a very early date by some form of primitive lamp, as according to mythological legends Apulcius makes Psyche drop hot oil from a lamp on Cupid. As early as the first century B.C., rushlight candles had come into use. There is a fragment of such a candle in the British Museum. About 1775 the sperm whale fishery came into being, in 1786 386 tons of sperm oil were imported into England, and sperm wax candles came into use. Somewhat later three important factors contributed to a considerable development in the art of lighting. These were :—

1. The invention of the Argand lamp in 1784;
2. The initiation of the coal gas industry in the early days of the nineteenth century by Murdoch and Winser; and
3. The birth of the petroleum industry nearly half a century later.

The rate at which these industries developed is an index of the magnitude of the latent demand for better illumination in those days. To the satisfaction of that demand the petroleum industry devoted itself for many years, kerosine being the centre of gravity to the industry. This has now completely changed, and kerosine no longer plays the leading part. Nevertheless, the quantities used for illuminating purposes are still so great that the subject has by no means lost its importance.

A few words on the development of the kerosine lamp and on the liquid illuminants first used may not be out of place as an introduction to the subject.

The first invention of importance was undoubtedly that of Ami Argand, who in 1782 devised a lamp in which arrangements were made for regulating and directing the supply of air, thus making possible a clear steady, smokeless flame. In his patent he claims " to give neither smoak nor smell, and to give considerably more light than any lamp hitherto known." His first lamp had an iron chimney suspended over the flame, but this was soon replaced by one of glass. The wick was tubular, the necessary air being supplied through the centre tube as well as outside through the perforated metal platform on which the chimney stood.

The oil was supplied to the wick by means of a tube, the reservoir being above the wick. The plain cylindrical chimney of Argand was modified to a tapered form by Smethurst, the lower part of the chimney being widened out to a bulb. A great advance was made when a flat wick was forced to adjust itself to an annular tube, as in present-day lamps. The burner was also modified by the introduction of a plate,

the so-called "Liverpool button," above the wick, the function of which was to direct the air coming up the central tube against the inner wall of the flame in order to improve the combustion.

In 1852 Stobwasser designed an Argand burner for use with coal oil. J. H. Austen introduced into the United States the Vienna burner, and Young produced the first English mineral oil lamp for shale oil. This lamp, known as the "oxydate lamp," had a flat metallic tube within which the wick was raised and lowered by a simple lever, the air was supplied by means of an elliptical deflector or cone, and a glass chimney was fitted. In 1865 Hinks introduced the well-known Duplex burner. Developments then went apace, and a host of other lamps of great variety appeared on the scene.

The illuminants in use before the advent of kerosine were vegetable and similar oils and the so-called "camphine," a mixture of alcohol and oil of turpentine.

About the middle of the nineteenth century manufacturers began to turn their attention to the production of mineral oils. In 1840 a "coal oil" was produced in France by the distillation of bituminous coals. Similar oils were made in America. The Kerosene Oil Company of New York began operations in 1854, working, under Gessner's patents, on the Albertite of Nova Scotia. Within twenty years fifty or more coal oil refineries had sprung up in the United States. In 1857 Playfair found an oil in the Atherstone Colliery. Young distilled and refined this oil and later initiated the famous Scottish shale oil industry. In 1855 Professor Silliman, of Yale, who had done some work on "rock oil," predicted that from that crude material "as good an illuminant as any the world knew might be made."

In 1857 the Carbon Oil Co. received their first consignment of twelve barrels of crude petroleum from Tarentum, Pa., and worked it up into kerosine. This was the beginning of the history of petroleum as an illuminant.

The old type of wick-fed lamp, because of its cheapness and simplicity, is still by far the most widely used, but several types of incandescent mantle lamps in which the kerosine is vapourised and mixed with air before combustion, and which are much more efficient, are coming more and more into use, particularly for special purposes. In this paper, however, the burning of kerosine in lamps of the wick-fed luminous flame type only will be considered. This is a subject apparently simple, but actually difficult, about which little has been published. The authors feel that although they have by no means adequately dealt with the subject, the data and considerations herewith put forward are of sufficient interest to deserve attention and perhaps to stimulate discussion and further work.

The behaviour of the flame when the lamp is first lit depends mostly on the chemical character of the kerosine, considered, of course, in relation to the type and construction of the lamp used; and its subsequent behaviour depends largely on its physical properties again in relation to the construction of the lamp.

The problem of devising for the examination of any product laboratory tests which have some definite relation to the behaviour of the product in actual use is often one of great difficulty. Too often tests are carried out (even laid down in specifications) which are not only useless, but worse still, sometimes misleading, as an indication of the way in which a product will behave under service conditions.

In order to tackle this problem it is necessary in the first place to be quite clear as to the requirements to which a good illuminating kerosine must conform. Apart from the æsthetic considerations of colour and odour, a good illuminating oil :—

(a) must have a good initial illuminating value;

(b) must have the power of retaining this good value as the oil is consumed; and

(c) must not cause deposits of any kind on the lamp chimney.

All essential features will be found to fall under these three heads. If an oil fulfils these three conditions it will be a satisfactory illuminant in any ordinary wick-fed luminous flame lamp of the types in general use. The primary problem is, therefore, that of finding out what characters or properties of the kerosine are related to those requirements, and the secondary one is that of designing laboratory tests which will give reliable measures of these characters.

The burning quality of any kerosine will obviously depend on three main factors: (a) its chemical composition, (b) its physical properties, both considered in relation to the construction of the lamp, and (c) the impurities present.

It will be as well to take the last first as being simplest.

A good kerosine should presumably con-

sist entirely of hydrocarbons. The only impurities likely to be found in a kerosine are sulphur compounds, oil soluble naphthenates, or sulphonates. Naphthenates or sulphonates of sodium would presumably be undesirable impurities, as being non-volatile they would tend to augment carbonisation of the wick. Attempts were made to determine the ash of various kerosines, but the quantities found were so minute as to be outside the range of a practical method. The sulphur compound impurities, however, play an important part in that they are largely responsible for the formation of bloom in the chimney, the white bloom as distinct from a dirty bloom caused by smoke.

The formation of this white bloom depends not only on the presence of sulphur compounds in the oil but also on the presence of impurities in the atmosphere. The same kerosine, burnt under the same conditions as regards lamp, but under various atmospheric conditions, will display varying amounts of bloom. The incidence of a smoke fog particularly increases the bloom formation. The presence of ammonia in the atmosphere in which the oil is burning also induces the formation of bloom. The presence of ammonium salts in the bloom may easily be detected by dissolving it off and testing in the usual way.

This points to the importance of a pure atmosphere for the carrying out of burning tests, or else the making of a blank or comparative test with a kerosine of known properties simultaneously. Another factor which affects bloom formation is that of the alkali in the glass of the chimney. Bloom is always more marked when using a new lamp glass and such bloom contains sodium sulphate.

After a lamp chimney has been used and washed several times the influence of this factor disappears. There are thus two obvious pitfalls to be avoided if bloom formation is to be accurately estimated.

However, in an ammonia-free atmosphere using an old and often washed lamp glass, bloom still forms in certain types of lamp if the kerosine contains a relatively high percentage of sulphur. Such bloom appears to consist largely of organic sulphonic acids or bodies of similar nature, but it contains also inorganic constituents. In order to eliminate the effect of the glass a chimney of silica was obtained. A brownish bloom on this chimney, which on extraction with benzol yielded some heavy oily matter, was dissolved off in dilute nitric acid. It was found to contain sulphates of ammonium and sodium with traces of potassium and calcium. It is considered that these latter may be derived from the wick, the ash of which contains these constituents.

It is, of course well known that if an ordinary household lamp is lighted and left untouched the flame will steadily decrease as the oil is consumed. In such cases it is often taken for granted that this decrease in candle power is an important indication of the quality of the kerosine and is due to : (1) the choking of the wick by heavier fractions of the oil or by impurities; (2) the carbonisation of the top of the wick; (3) the gradual removal of the lighter fractions of the oil; and (4) the fall of the oil level and consequent increase in the work which has to be done by the wick in lifting the oil to the flame.

It is of interest to determine which, if any, of these factors are of real importance.

(1) The choking of the wick is obviously not of any considerable importance, as it was found possible to use the same wick over and over again without causing any marked difference in the behaviour of the oil under test. It is realised, however, that there may come a time when a wick does become adversely affected by the presence of impurities.

(2) Provided that the kerosine being burnt is free from any abnormal amounts of aromatic bodies and high boiling fractions it was found that the carbonisation could be attributed to the supply of kerosine being insufficient to maintain the required flame. In other words, the wick was being burnt instead of the oil.

(3) The possibility of any change in the composition of the kerosine taking place during a burning test was effectively disposed of by carrying out distillation tests before, during and after a prolonged burning test. The distillation figures obtained showed no variation at all, thus establishing conclusively that fractional removal of the more volatile constituents does not take place during a prolonged period of burning. This point was cleared up as long as 1883 by Nakamura (J.S.C.I., 1883).

The fall in the oil level was, however, shown to have by far the greatest effect upon the behaviour of the oil. This was demonstrated in various ways. In the first place a constant level device was attached to a standard testing lamp. When working under the ordinary standard conditions it was found that the usual drop in candle power did not take place, in fact that a

uniform candle power was maintained throughout the test. As a matter of interest the test was continued for 72 hours without any appreciable fall in candle power.

This led to the production of a lamp with a very shallow flat reservoir. With this shallow reservoir it was found that with any wel-refined kerosine which would give a satisfactory initial candle power, a steady flame could be maintained throughout the test without any drop in candle power taking place.

On the other hand lamps may be purchased which will not burn even the very best kerosines unless the reservoir is more than quarter full.

The reason for this is that the oil level when the reservoir is quarter full is nearly ten inches below the flame, so that whatever the viscosity and capillarity of the oil may be, the wick is unable to supply sufficient oil to maintain the flame.

GERMAN SCIENCE.

A Review of Some Recent Chemical Books.

The remarkable recovery which has taken place in Germany since the stabilisation and the introduction of the *rentenmark* must have impressed the whole world. Not a little of the credit for this achievement is due to the scientific basis and organisation of their industrial concerns.

Anyone travelling in Germany cannot fail to observe the great activity displayed in the industrial districts.

This prosperity is shared by the chemical industries in no little measure, and is also reflected in the ever-increasing output of scientific books. Judging by the number which reach the *Chemical News* (they outnumber those from all other foreign countries) the publication of scientific works must exceed that in Great Britain. This in spite of the fact that the English-speaking peoples far out-number those whose tongue is German.

Presumably a good number of these volumes must be sold outside Germany and serve to maintain the tradition that a successful scientist must acquire a knowledge of German. An increasing number of Indians and Japanese publish their researches in German, too.

Unlike so many of the publications appearing in England, very few of the new German books are for beginners. It is true that the fundamental principles of science are widely discussed but usually in a manner suitable only for the advanced student. Many of these volumes deal with very specialised branches or with borderline subjects and can only appeal to a restricted public to whom a British publisher would not venture to appeal.

Although published in Germany, three of the works below are from workers in other countries. Dr. Suida is an Austrian; Dr. Margosches is Professor at the German Technical College in Brünn (Brno, Czecho-Slovakia); and Dr. Lifschitz is Privatdocent at Groningen University.

(1) *Fortschritte in der Kautschuk-Technologie.* By Dr. F. Kirchof. Pp. XI. + 200. Dresden and Leipzig: Theodor Steinkopff. 1927. Price 12 marks.

Dr. Kirchof's Monograph in Prof. Rassow's series (published by Steinkopff) is intended for chemists and technologists as well as for rubber specialists. It gives, with numerous illustrations and many tables, a complete survey of the subject with special reference to the progress during the last few years. The author has dealt with the problems to be met with in the various stages in the production of rubber goods from the extraction of the latex to the finished article. The treatment of the latex and the sections on vulcanisation might well have been expanded and it may be noted in passing that the "regeneration" of rubber is claiming more and more attention.

(2) *Lehrbuch der Enzyme.* By Prof. Carl Oppenheimer and Dr. R. Kuhn. Pp. X + 660. Leipzig: Georg Thieme. 1927. Price 33 marks (bound, 36 marks).

This compendious work is really the fifth edition of Prof. Oppenheimer's *Fermente und Ihre Wirkungen* which appeared in 1900. It is a textbook written from the general standpoint of one anxious to give a complete and up-to-date account of the subject. It is also written in a clear style which will commend it to English readers.

Following a general introduction, the enzymes are classified systematically according to the substances they are associated with—hydrolytic enzymes, synthesising enzymes and zymases. Sections are devoted to the esterases, carbohydrases, nucleases, amidases, proteases, etc. The specific enzymes and their chemical activities, reactions and properties are fully considered. Much work has been done in connection with enzymes during the last few years and Prof. Oppenheimer and his collaborator, Prof. Kuhn, have had a notable share in this which gives an added value to their book.

Much remains to be done, however, for the conditions under which proteins are synthesised (Danilevsky, Hesse, and others) are not yet understood. It is also noteworthy that the purification of enzymes is often attended with marked effects upon their specific activities.

(3) *Die Technische Herstellung Konzentrieter Essigsäure.* By DR. H. SUIDA. Pp. 14. Vienna: Oesterr. Chem. Zeitung. 1927.

Dr. Suida gives an account of the various methods of concentrating acetic acid, a subject in which he has specialised and introduced patents of his own. His pamphlet is a reprint from the Austrian *Chemiker Zeitung*.

(*To be Continued.*)

CORRESPONDENCE.

A NOTE ON THE NUMERICAL ASSOCIATIONS OF ORDINAL NUMBERS AND ATOMIC WEIGHTS OF THE ELEMENTS.

Sir,

(*To the Editor of the* CHEMICAL NEWS).

The method here described enables a relationship to be established between a number and the resulting associated number. The procedure may be readily followed from the examples given.

1. The number 4693763 is an accurately determined Ni for a given system. The constant 4791027 is added to it, and the sum is multiplied by 934.

948479 × 934 = 8858,79386 . . . .(1)

The difference between the first portion of the number and twice the second, is multiplied by a combined constant 2494613.

(8858 - 158772) × 2494613 = 1813653 (2)

The difference of the last number from 4 gives the associated number. 2186347 is the association of 21, scandium, with the proportion 86347; the atomic weight of scandium is 45.1.

The quotient (2186347 + 1715127)/(2186347 - 1715127) is multiplied by 86347/451.

3901474/47122 × 86347/451 = 158517 (3)

The last number is practically equal to the second portion of the number above multiplied by 2. This result is typical.

The first number 8853 referred to 86347/451 is 5897 and 1 - 783860.

2. The initial number is 2859551, and is equal to the square root of the square of 12178 minus the square of 51.

7650578 × 934 = 7145,639852 . . . . (1)

(7145 - 1279704) × 2494613 = 1463164 . . . . (2)

4251963/821709 × 36836/5493 = 3470037 . . . . (3)

3470037/639852 × 247581 = 1342678 . (4)

The logarithm of the last number is 127972, twice the second part of the number. 24°.7581 is the angle of which the sine is 51/12178. The radians corresponding to the same give 369850. The ratio instead of the product in (3) gives 7716282. 7716282 - 639852 = 1317762; the latter by proportion 3470037/639852 gives 714647 compared with 7145.

It is possible to obtain remarkably accurate relationships by this method.

Yours, etc.,

A. SAKOSCHANSKY, B.Sc.

26, Castle Boulevard,
Nottingham.

New Patents.

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Latest Patent Applications.

14,217.—British Dyestuffs Corporation, Ltd.—Manufacture of vat dyestuffs. May 26th.

14,211.—Compagnie de Bethune.—Preparation of ethyl-sulphuric acid. May 26th.

14,056.—Frischer, H.—Methods of producing volatile acids. May 25th.

14,179.—I. G. Farbenindustrie Akt.-Ges. —Production of valuable hydrocarbons from mineral oils, etc. May 26th.

14,018.—Ormandy, W. R.—Manufacture of nitric acid. May 25th.

Specifications Published.

271,146.—British Synthetics, Ltd., and Higgins, E. B.—Manufacture of intermediate products suitable for the preparation of azo dyestuffs.

249,515.—Wyld, F. Lehnhoff.—Process for the manufacture of organic arsenic compounds.

250,955.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of aromatic aldehydes.

261,336.—Jansen, J. P. H.—Fermentation processes for the production of alcohol.

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SURDEX.

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"LAVENTIN."

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A SELECTIVE DISPLACEMENT OF 0.0153A IN X-RAY SPECTRAL LINES. PART VII.

By F. H. LORING.

In continuing this series of investigations, based upon a supposed X-ray-line displacement of about 0.0153A, from the last part (VI) — *Chemical News*, May 27, 1927, CXXXIV, 321—it should be of interest to consider a few further relations which are here given as Notes.

1.—It is of course understood that the several constants used in these studies must be directly or indirectly determined by independent experiments. When, however, the correlated values fall within the experimental range, as thus indicated, there is the probability that the relations made evident are of significance. The greatest difficulty seems to be in the variation of the R constants, of which there are several involved, as already shown. The following may be of interest in this connection :— Birge (*Phys. Rev.*, 1926, XXXVIII, 848) gives the value of R_{inf} as 109737.3. If, however, the value is taken as 109738.5, this magnitude may not be appreciably in error. Calling this $R_{inf\ ap}$, by the addition thereto of $\Delta a \times 10^4$ the previously-calculated value (see Part VI) is obtained, *viz* :— 109891.0

$R_{inf\ ap}$ can be evaluated as follows :—

$c\Delta_H \times 10^{-5} = 109746.1$, which is 7.6 higher than the corresponding value above. In this case c is taken as low as possible, whilst keeping just within the probable range of error of the new experimental value (2.99796×10^{10}), *viz* :— 2.99790×10^{10}.

Now adding $\Delta a \times 10^4$ to 109746.1 = 109898.63, which is 7.63 higher than the 109891.0 value, as in the previous comparison above, *i.e.*, the latter value, is substantially the same as the corresponding former one.

How far each set of these agreements represents a real relation, rather than a chance one, it is impossible to say. The agreements in this section are not very satisfactory, as they involve complications.

2.—Planck's constant, h, may be expressed in varied detail thus :—

$$\Delta a^{-1} \times 10^{-28} = 10^{-28}/\Delta a = h = 6.5560 \times 10^{-27}.$$

3.—From the whole-number relation previously shown (Part VI) it is possible to evaluate Δa from HeIIλ4685.809 (= the mean between the two best wave-length measurements, as given in the previous part), the value for Δa by this method is 0.01525328*. Then Δa, as thus obtained,

* It is, in a sense, absurd extending the calculation so far, as the wave-length is not known with a sufficient number of significant figures to justify so doing. It is of interest, nevertheless, to have nearly the full value for what it is worth, so that the non-significant figures can be cut off, or rounded off, at the seemingly appropriate place. In this case the value might be closely expressed as 0.0152533—by way of example. See in this connection Note 5.

multiplied by 24 to give Δ_H, and this product divided into 10^2 gives the value 273.165, which is, within the errors of measurement, in agreement with the experimental value for the absolute zero of temperature—see Note 8. This is obviously a chance coincidence and it means nothing. It serves, however, as a caution: not to believe implicitly in number coincidences *unsupported by suitable independent* evidence. *It is therefore feared that* some of the relations in this study, which seem to come out so well, are chance coincidences; but not all of them are fortuitous in the writer's opinion.

4.—Line-displacement phenomena in general is of interest, and the case of certain displaced lines of the variable star *β Lyræ* will be discussed without of course arriving at any conclusion though some promising numerical relations will be shown in connection with Δ_a. In Stratton's "Astronomical Physics," 1925, *the following summary will be quoted in full* as a basis for a scheme to follow. "A more complex problem has to be unravelled in the case of the variable *β Lyræ*. In this star we have the following factors present. First and simplest there is an absorption spectrum of type B8 which is displaced periodically in the same period as that of the complete magnitude variation of 12.9 days. This spectrum changes in displacement normally as though it were the spectrum of one component of a spectroscopic binary of small eccentricity with a range in radial velocity of 369 km./sec. The curve of the light period has two minima as in the case of a normal eclipsing binary, and this B8 spectrum drops slightly in intensity as the principal minimum, suggesting that the component to which it belongs is the brighter of the two stars of the binary system. Rossiter (*Astrophys. Journ.*, 1924, LX, 15) has detected in the velocity-curve a secondary oscillation, visible near principle minimum, due to the rotation of the partially *eclipsed component*. The other absorption spectrum, which diminishes rather more markedly in intensity at the secondary minimum of brightness, is of Class B5. The star to which it is presumably to be ascribed, shows only very small, if any, fluctuations in radial velocity, and is presumably far the more massive component of the two. In addition to these absorption spectra—and undisplaced [H] and [K] lines of calcium, so often found in early B type binaries—there is present a spectrum of bright bands of varying intensity and structure which agrees in selection of lines fairly well with the B5 component. Where the bright bands occur we often find other dark lines present which may be structural in the bright bands, or at least refer to the same source as the bright bands and, perhaps, the B5 absorption lines. In some cases we may have, *corresponding to* one spectral line, a B8 component with *its appropriate* displacement, a B5 component with its appropriate displacement, a broad, bright band (several Ångström units broad), and several narrow absorption lines crossing or bordering the bright band. In some cases these extra absorption lines show a regularity of structure which seems to relate them closely to the bright band. Similar phenomena have been noted for novæ and for such a star as *γ Cassiopeiæ*. In the case of *β Lyræ* this regularity of structure is *almost more* pronounced. Curtiss gives as *the displacements* of the dark components of Hγ *from the normal positions of the* line − 7.30, − 5.89, 4.56, − 3.17, + 2.20, + 3.32, + 4.48, + 6.73A. Save for the sixth and eighth components the spacing is very regular, the missing centre components being possibly blended with the B5 or B8 absorption. Many theories have been proposed to account for the complex phenoment of *β Lyræ*. Most of them postulate a binary system in an early stage of evolution with the two components close together and involved in an extensive atmosphere. According to this view the bright bands are due to the gaseous envelope in part, but also in part to one of the two stars, the variations in the intensity curve of the bright bands being due partly to eclipses of this star and partly to the varying absorptions which its light undergoes in different phases. The width of the bands is due mainly to the rotation of the gaseous envelope, as in the case of novæ. The regular structure in the bands may be traced to the same cause as in novæ (*i.e.*, some regularities in the *rotational movements of the envelope*) or else to some system of regular and successive reversals of lines due to abrupt changes in the density gradient; it cannot, however, yet be claimed that we have found the key to the problem."

Selecting from the above interesting phenomena all the particular line-displacements given and arranging these in tabular form, with the differences set out, it will be seen that the regularity can be reduced to $n\Delta_a$, when *n* is a whole number; but the values are not *accurately enough* known to

make a rigorous comparison in this way. The best that can be done is to take an average value. An attempt is made along these lines as here shown.

A.U.			
- 7.30			
	1.41		
- 5.89			
	1.33		
- 4.56			
	1.39		
- 3.17			
Mean value			1.3766
Ideal value			1.3728
- Difference			0.0038

+ 2.20			
	1.12		
+ 3.32			
	1.16		
+ 4.48			
	1.125	= 2.25	
	1.125		
+ 6.73			
Mean value			1.1325
Ideal value			1.1287
- Difference			0.0038

The respective ideal values above are $90\Delta a$ and $74\Delta a$, Δa having the value indicated in the foot-note. A practically exact agreement *can* be obtained in both cases by using $\Delta a = 0.0153$; but, the equal - Differences above come to the same thing, and this is a little more probable, because (1) exact agreements are generally coincidences, and (2) some systematic or other error is to be expected in cases of this kind, though astronomical observations are very accurate and no money is usually spared in instrumental equipment. These particular agreements rest on very slender evidence, but it is of interest to study such matters in connection with the displacements or difference values in the case of X-rays, etc. The intial values may be treated in the same way.

5.—There is the possibility that, in manipulating numbers, a *certain* value taken as a sort of unit will appear in some *such* multiple way as indicated throughout these studies. Therefore, the peculiarity of numbers must not be confused with experimental analysis, yet the quantum theory may rest on, or conform to, some peculiarity of precisely this kind. Experiment should, obviously, decide any issue of this nature. It was partly on account of this number idea that some of the calculations were carried out so far into the decimal region (or so far to the right, as the decimal point need not be a sort of datum line for accuracy of measurement), hoping that some common value might be found which would fit into all the constants involved. A partial success only in this direction can be recorded in these studies.

6.—The new value for the velocity of light (see above) as recently determined by A. A. Michelson, will affect slightly some of the calculated results given by those who have made a special study of the basic constants involved in atomic physics. It is to be noted in this connection that some of Paschen's very fine measurements of several of the constants involved in these studies still hold the field as standards of accuracy. It will be expected that a revised set of values will be prepared by Birge in due time. It is, however, to be observed that the above-mentioned determination of the velocity of light—the most important constant of all—is not yet final as some further confirmatory experiments are in hand. The new value is no doubt very near to the final one judging from the great accuracy of the work carried out at much expense. It will not be out of place to quote almost in full Birge's last (1926) report which appeared in the *Physical Review* (*loc. cit.*) in abstract form.

" It is possible to measure certain relations between the constants c, e, h and e/m with a greater accuracy than the individual constants can be determined. These measured relations thus constitute conditions to be observed in the adoption of any *consistent system* of values. Adopting the usual values $c = 2.9986 \times 10^{10}$, and $e = 4.774 \times 10^{-10}$, the at present most probable value of h is 6.557×10^{-27}, and this agrees well with the values obtained from h/e (6.556 *plus* or *minus* 0.0044 from recent ionisation potential work by Lawrence, and 6.556 *plus* or *minus* 0.005 from the continuous X-ray spectrum). Adopting $h = 6.557$, and c and e as given, the known value of the Rydberg constant (R_{inf} = 109737.3 *plus* or *minus* 0.3 cm^{-1}) then *requires* $e/m = 1.7597 \times 10^7$ E.M.U. This agrees well with the most probable value 1.761 *plus* or *minus* 0.002, obtained by Babcock from complex Zeeman effect. Adopting 1.760, some derived constants are, $h/e = 1.3735 \times 10^{-17}$ erg. sec. (E.S.U.)$^{-1}$, $hc^2/e = 12{,}350$ volt A, and $e \times 10^8/(hc^2) = 8097.1$ volt^{-1} cm^{-1} . . . . "

7.—In making interferometer measurements on the Balmer series lines W. V. Houston (*Phys. Review*, 1927 xxix, 749, abstract), in conclusion says:— "The intensity relations predicted by Sommerfeld and Unsöld make it possible to compute the position of each of the five components from the observed positions of two centres of gravity. With the interferometer wavelengths of the first three lines of the Balmer series R_H is found to be 109677.67 *plus* or *minus* 0.01. Thus the accuracy of e/m, determined spectroscopically, is governed by the accuracy of R_{He} From a mean of the values of Paschen and of Leo on He 4686, e/m is found to be 1.769 and it seems improbable that it can be below 1.765. This does not agree with the Zeeman effect measurements of Babcock, so that further work will be done with the interferometer to improve the value of R_{He}."

8.—Having referred above to the $-$ C° temperature value at the absolute zero, the following determinations may be noted:—Berthelot (1907): H_2 = 273.05; air = 273.19; CO_2 = 273.10. Buckingham (1908): H_2 = 273.06; N_2 = 273.25; air = 273.27; CO_2 = 273.12. Rose-Innes (1908): H_2 = 273.13; N_2 = 273.14. The general mean value of all the above determinations is about $-$ 273.15°.

9.—Coincidences in numbers as here shown involve a faith in whole-number relations, assuming that they are significant. A coincidence that may seem absurd, because the quantities are not comparable, may arise from a whole-number relation between two systems of calculation, so that the continuity, so to speak, is preserved. Reciprocal quantities are also involved in these relations as is evident.

10.—Referring to the Tables (see earlier parts) the correlation with the $K\alpha_1$ line of gallium is not unexpected, as this element may have been present in the aluminium used in the construction of the X-ray tube.

11.—Attention may be drawn to a paper by F. Paschen in the *Annalen der Physik* (1927, 82, 689), on the relativity effect involved in the fine-line structure. In a preliminary calculation using the equation as cited in Part V. (*Chemical News*, p. 291) the following constants were used, the values being in correlationship:— 109737.1, 4.774, 6.55, 2.9985, Δ_H being 0.3647. e/m = 1.769. It will be seen that the *infinity* value for R is used.

TUBERCULOSIS IN INDIA.

By Rai Bahadur Gopal Chandra Chatterjee, M.B.
(Professor of Protozoology, University of Calcutta.)

Abstract.

Prosperity of the national life of a country depends on various well-known factors such as productivity of soil, commerce, industry, political life, advantages of climate, etc., but there are also several unseen forces which act on the national life in shaping the well-being of the nation. Many of these are made subjects of investigation by the European nations, and their nature to light. Remedies based on this knowledge are being applied constantly, so that well-being of the nation is being gradually improved. For example, the action of even the sun's rays on the health of the people living in tropical countries, in influencing their economic life, is being investigated and remedies based on this knowledge are being suggested and applied.

In the same way, the effect of the infectious diseases in influencing the economic life of a nation is given special importance in European countries. Intensive study of these problems has given definite knowledge of the mysteries of these infectious diseases, caused as they are by invisible germs, and remedies based on this knowledge have suggested measures, application of which has given a great impetus to the well-being of the nations concerned. For example, from a publication of the socio-medical department of Yugoslavia, we find certain statements made in the preface of the publication which will make the point clear to the readers of this article. In it, it is stated that this nation, the youngest one in this world, having taken its birth out of the turmoils of the world war, has lost four millions of its souls, out of a total population of twelve millions, half of which was due to the enemy's action, the other half being due to infectious diseases. The former is an occasional affair, the latter, however, is a perennial one; this has given rise to a strong desire in the nation to live healthy lives, free from all infectious diseases, in order to preserve it from extinction. Accordingly, the nation has decided to open out, throughout the country, a large number of so-called socio-medical centres for doing social service based on intimate knowledge of the mysteries of infectious diseases. By this way, they have been able to do an immense amount of benefit to

the nation which otherwise would have been wiped out from the face of the earth. In complete contrast to this is the condition of the people of Turkey who, in spite of the best efforts of their saviour Mustafa Kamal Pasha to save them from the clutches of the European invaders of the country, are dying inch by inch through infectious diseases, so much so, that a writer in one of the leading journals of Europe, remarked that though the sword of Kamal Pasha may be of service to preserve this nation from their European invaders for the time being, the infectious diseases which are rampant throughout the country against which no systematic attempts are being made, will surely destroy the nation in the near future. Similar is the condition of our country, where the politically-minded leaders have given all their thoughts on its political regeneration; not a single thought has been spent on prevention of infectious diseases which are sapping the foundation of the nation. Statistics of our country published broadcast showing the effects of inroads of epidemic diseases, have not appealed to them.—*Indian Medical Record.*

General Notes.

'AVENYL.'

(2-myristoxymercuri-3-hydroxy-benzaldehyde).

A PREPARATION OF MERCURY DISSOLVED IN HYDNOCARPUS OIL FOR USE IN SYPHILO-LEPROUS AFFECTIONS.

A decided advance towards a solution of the problem of treating leprosy complicated by the presence of a positive Wassermann reaction, is achieved by the introduction of 'Avenyl,' a preparation which is the outcome of original work in the Wellcome Chemical Research Laboratories. As the result of tests carried out under the Indian Research Fund Association and extending over two years a clinical report covering 30 cases has been issued. These cases lead to the conclusion that 'Avenyl' is a "most safe and effective remedy in the treatment of leprosy when the Wassermann Reaction is positive."

Hydnocarpus oil, acknowledged as one of the most important drugs in the treatment of leprosy, is used as the vehicle for this preparation of mercury and probably contributes to the favourable results. The dangerous effects of the use of arsenical compounds in leprosy complicated by syphilis are avoided by the use of 'Avenyl.' Hydnocarpus oil given alone for prolonged periods has failed to render the Wassermann Reaction negative in this type of case. 'Avenyl' administration in the series of 30 Wassermann-positive cases of leprosy produced a marked beneficial effect, in that more than 50 per cent., after treatment, gave a negative Wassermann Reaction. Ten of these were only given one course of 15 injections and only one case required 4 such courses to produce the same effect. Where 'Avenyl' treatment did not alter the Wasserman Reaction, courses of arsenical preparations, subsequently administered, also failed. 'Avenyl' produced general improvement in the lesions manifested in cases of leprosy complicated by a Wassermann-positive Reaction.

'Avenyl' is non-toxic, is administered with ease by subcutaneous injection and is issued ready for use as 'Hypoloid' in hermetically sealed phials of 10 c.c. by Burroughs Wellcome and Co.

THE WOOD DISTILLATES AND WOOD EXTRACTS INDUSTRY IN CANADA, 1926.

Production of wood distillates and extracts in Canada in 1926 amounted in value to $1,753,993, a decline of 13 per cent. from 1925 and the lowest output value on record for this industry, according to the Dominion Bureau of Statistics at Ottawa. Only 9 establishments were in operation in 1926 as against 10 in 1925 and 12 in 1924. There were 5 distillation plants in Ontario, 2 distillation plants and 1 refinery in Quebec, while 1 other concern in the latter province extracted turpentine as a main product.

Employing a capital of $2,217,049, the 9 plants gave work to an average of 255 persons during the year and used raw materials worth $827,575 in the manufacturing operations. In 1925 an average of 309 persons were employed and materials used cost $847,663. The value added by manufacturing was $967,418 in 1926 as compared with $1,142,333 in 1925.

Charcoal, methyl alcohol, acetate of lime, acetic acid, formaldehyde and turpen- were the principal products.

Exports of methyl alcohol during 1926 showed a decline to 37,196 gallons as com-

pared with 153,419 gallons in 1925 and 155,335 gallons in 1924. Synthetic methanol made in Germany has seriously affected Canada's export market for this commodity.

CANADIAN ZINC PRODUCTION, 1926.

Finally revised statistics on the production of zinc for the year 1926 as reported by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics, shew that Canada established a new high record for production of this metal with a total of 149,938,105 pounds (74,969 tone), which, valued at the average London price for the year of 7.41 cents per pound, was worth $11,110,413. The 1925 output amounted to 109,268,511 pounds (54,634 tons) which valued at the average St. Louis price of 7.622 cents per pound, was computed to be worth $8,328,446.

THE INDUSTRIAL FELLOWSHIPS OF MELLON INSTITUTE.

(Abstract, *Industrial and Engineering Chemistry.*)

The annual report recently submitted by Director Edward R. Weidlein to the Mellon Institute Committee of the Trustees of the University of Pittsburg describes the scientific and technologic service of the Industrial Fellowship System during the Institute's fiscal year ended February 28, 1927, which is the sixteenth since the establishment of the Industrial Fellowship System at the University of Pittsburg.

According to Director Weidlein, the Institute's industrial research activities have been attended with success throughouh the year, and he extols the fulfilment of their duties by the industrial fellowship incumbents. To quote him : " The ideals which from the first have actuated the Fellows of the Institute have led to the sodilarity of th Institution. No guild has a sounder code of ethics; no professional group stronger ties of co-operation and brotherhood. There are other driving motives, besides the constraint of contractual obligations, which keep the fellows to their tasks and promote the well-being of the fellowships. The utility of their work, the craving for results, the fascination of what to them is a very interesting sport, move all the fellows more effectively than the articles of agreement governing the operation of their fellowships."

It is mentioned that the Institute established two new departments during the year. " On December 1, 1926, the operation of the Institute's department of analytical chemistry was begun under the supervision of Dr. George D. Beal, formerly professor of analytical and food chemistry in the University of Illinois, since September 1, 1926, an assistant director of the Institute in charge of the industrial fellowships in the field of pharmaceutical chemistry. Dr. William W. Mills, the analyst in this department, aids institutional industrial fellows by making analyses and tests incidental to fellowship researches, and sees that the Institute's purchases of chemical supplies conform to specifications. He also has the privilege of conducting research in analytical chemistry.

" On March 1, 1927, another new department was put into operation in the Institute, namely, a definite department of research in pure chemistry, with Dr. Leonard H. Cretcher as the head. This Department, like the department of analytical chemistry, is an integral part of the Institute.

At the close of the Institute's fiscal year, on February 28, 1927, fifty-eight industrial fellowships were operating, employing one hundred and two research chemists and engineers. The sum of $598,493 was paid during the year in support of research in the Institute by the fellowship donors—an increase of $70,942 over the payments of the preceding year. The total amount of money appropriated by companies and associations to the Institute, for the sixteen years ended February 28, 1927, was $4,318,397, all of which was disbursed in sustaining fellowship research.

The extent and variety of the Institute's scientific investigations on behalf of industry are shown in the appended list of the industrial fellowships in operation during the entire fiscal year, February 28, 1926, to February 28, 1927. There were sixty-seven fellowshijs—twenty-two multiple fellowships and forty-five individual fellowships—on which 124 scientists and engineers were occupied in research.

LIVINGSTONE COLLEGE.

June 10 was Commemoration Day at the above institution, which is located at Leyton, London. Sir John Rose Bradford, President of the Royal College of Physicians, presided as chairman, and in his address he dwelt upon the usefulness of the College.

THE ANNUAL GENERAL MEETING OF THE KOGYO KWOGAKU KWAI. (SOCIETY OF CHEMICAL INDUSTRY, JAPAN.)

The Thirtieth Annual General Meeting of the Society was held on April 2, 3 and 4, in Tokyo. It began at 9.30 a.m. on the first morning with the business part of the meeting, followed by the reading of the technical papers (55), and ended with the excursions to the Yokohama Municipal Gas Works and the Glass Bottle Factory of the Dai-Nippon Beer Co., both in Yokohama.

The Society's Medals for the Special Merit in Research were awarded to Dr. Tsujimoto and Dr. Toyama, both of whom are chemists to the Tokyo Imperial Industrial Laboratory, and another of the Society's Medals was presented to Dr. Itsuzo Hata, chemist and manager of the Imperial Artificial Silk Co., in recognition of his achievements in and contributions to the development of the artificial silk industry of this country. Dr. Tsujimoto is well known for his wide and thorough investigations in fats and fatty oils in general, and those parts of his work which relate to the marine animal oils were made the subject of the awarding the medal this time. Not only he has identified the compositions of various marine animal oils but he is the discoverer of clupanodonic acid ($C_{22}H_{34}O_2$), squalene ($C_{30}H_{50}$), pristane ($C_{18}H_{38}$) named by Dr. Toyama, batyl alchol ($C_{21}H_{11}O_3$), selachyl alcohol ($C_{21}H_{12}O_3$), selachoceric acid ($C_{24}H_{18}O_2$), selacholeic acid ($C_{25}H_{16}O_2$) and tetradecylenic acid ($C_{11}H_{26}O_2$). Dr. Toyama has also made thorough investigations on the fatty acids of various kinds of whales, sharks and rays, and, in addition to this, he has made valuable contributions to the chemistry of fatty oils with regards to the unsaponifiable matter of liver oils of sharks and rays, namely, the discovery of presence of higher polyatomic alcohols such as chimyl alcohol $C_{19}H_{10}O_3$, batyl and selahyl alcohols.

WORLD ECONOMIC CONFERENCE.

A meeting at Geneva under the auspices of the League of Nations has just concluded its deliberations on the economic problems and conditions prevailing in the world at the present time. The report is published at 1/- and is a valuable document covering the conditions, and future prospects of industry, commerce and agriculture.

The report states that there was great unanimity of opinion in such directions as the breaking down of tariff barriers and the introduction of free trade or "liberty of trading." One of the most important outcomes of the discussions is the realisation of the essential interdependence of agriculture, industry and commerce.

ELECTRICAL MEASUREMENTS AT RADIO FREQUENCIES.

By S. L. Brown and M. Y. Colby.

Abstract.

Methods of measuring resistance, inductance, capacity, and impedance at radio frequencies.—Resistance, inductance, capacity and impedance are measured at radio frequencies with the aid of a vacuum tube voltmeter. The experiments described and the data presented illustrate methods of measurement at radio frequencies that are comparable to the corresponding measurements at low frequencies with regard to both simplicity and accuracy. The results indicate that the resistance of a circuit may be measured with an accuracy of one per cent. at a frequency of several million cycles per second when the value of the resistance is of the order of 0.01 ohm. Much lower values can be measured with a reasonable degree of accuracy. The calculated value of the high frequency resistance of No. 22 copper wire differs from the measured value by less than one per cent. The inductance of a portion of a circuit may be measured by a voltmeter-ammeter method with an accuracy of one per cent. even though the value of the inductance be only a small fraction of a micro-henry. The calculated values of the inductance of either a circular coil of one turn or two parallel wires forming a return circuit agree with the measured values. Capacities of the same order of magnitude as the smallest readable variation of the variable standard condenser which is used to turn the circuit may be very quickly and easily determined. The measured and the calculated values of the capacity of two parallel wires are in very close agreement. Certain rolled plate types of telephone condensers have sufficient internal inductance to cause them to resonate at low radio frequencies.

The methods of making many radio frequency measurements have been improved: (a) By using such a low resistance circuit that the coupling to the source of power oculd be made very loose. The coefficient of coupling was frequently as low as 1×10^{-6}. (b) By using a negligible amount of

·r from the oscillator, with the result the e.m.f. induced in the tuned circuit .ined constant. The power drawn sel- exceeded 2 × 10-° watts. (c) By em- ng a sensitive and accurate voltmeter is independent of frequency. Voltage ges of 0.2 milli-volts could be detected this instruments.—*Physical Review*, A.

'ROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

e following papers were read in title e meeting on June 2 :—

nsile Tests on Alloy Crystals.—Parts I., and III. By C. F. ELAM. *Com-* cated by H. C. H. Carpenter, F.R.S.

'stals of alloys of aluminium and zinc, ıining up to 18 per cent. zinc, have prepared by the method of straining ved by heat-treatment. Distortion urements and X-ray measurements been made in order to determine the tion and plane of slip. This was found in a direction parallel to the diagonal e cube (*i.e.*, in a [110] direction) and ι octahedral [111] plane, as in alumin- The alloys showed increased resis- to shear with increased zinc content, he amount of elongation before frac- was reduced. Fracture occurred on a sometimes parallel to the slip-plane, ometimes making a small angle with

'stals of a Zn-Cu alloy were made by ıg brass rods, containing 70 per cent. ·r and 30 per cent. zinc, in graphite and slowly cooling from one end. ng amounts of zinc were lost in the ss. The rods after annealing appeared geneous and gave consistent X-ray :ions.

tortion measurements were made; in case these showed that slip had oc- l on an octahedral [111] plane in a direction, as in copper. The type of e slipping, *i.e.*, slip on two octahedral ; equally inclined to the axis, familiar other metals of this crystal structure, ɔt occur. Slip proceeded on the first longer than would have been ex- l, when there was an abrupt change to a second plane, which in its turn place again to the first plane in two ls examined.

· elongation before fracture amounted : case to 168 per cent.

istance to shear in early stages of ex- tension differed only slightly from pure copper, being rather less. Final shear- stress was greater.

The Crystal Structure of α-Manganese. By A. J. BRADLEY AND J. THEWLIS. Com- municated by W. L. Bragg, F.R.S.

(1) The structure of α-manganese has been deduced from the data of Westgren and Phragmen, who had shown that it was cubic, the lattice dimensions being 8.894 A.

(2) α-manganese contains 58 atoms per unit cell.

(3) The space group is Td^3. There are four sets of equivalent positions, contain- ing respectively 2, 8, 24 and 24 atoms.

(4) The exact position of the atoms is de- fined by five parameters, which have been evaluated.

(5) The structure is based on a single body-centred cubic lattice, but each point is replaced by a cluster of atoms, with tetrahedral symmetry.

(6) The interatomic distances range from 2.25 A to 2.95 A, indicating an unequal dis- tribution of electrons between the various atoms.

On Fresnel's Convection Coefficient in General Relativity. By N. R. SEN. Com- municated by A. S. Eddington, F.R.S.

A simple explanation of Fresnel's convec- tion coefficient is furnished by Einstein's Addition Law of two velocities. But one would expect to obtain this law in the case of the addition of a small velocity to the velocity of light directly from Maxwell's electromagnetic equations in a moving material medium. We can take a gravita- tional field and try to obtain solutions of the form $f\ (x_1 - vt)$ of the modified Max- well equations, in which there are two electromagnetic tensors F and H, which must also be connencted by two more simple relations in a transparent medium.

The conditions for the existence of the above plane waves lead to an algebraic quadratic equation for v, whose solution really gives Einstein's Addition Theorem for the electromagnetic wave velocity and the velocity of the medium. The usual formulæ for both transverse and longitu- dinal motions can be established. The G- field within the material medium is assumed to be of a particular type in each case. Einstein's field equations now lead, in general, to six relations among twelve in- dependent quantities.

On the Skulls of Early Tertiary Suidae Together with an Account of the Otic Region in some other Primitive Artio- dactyla. By HELGA PEARSON. Communi- cated by Prof. D. M. S. Watson, F.R.S.

European palaeontologists have given much attention during recent years to the study of the teeth of primitive mammals, these being the parts of the skeleton most commonly preserved. In this paper, an attempt is made to bring forward new evidence as to the relationships of the early European Artiodactyla by a study of the otic region of the comparatively few skulls known.

Starting work with the problem of the inter-relationships of the early tertiary Suidae, it became necessary to reject from this family certain genera usually associated with it. This led to an examination of the otic region in those families, such as the Anthrocotheriidae and Hippopotamidae, that are generally regarded as most nearly allied to the Suidae.

Finally, all available early Artiodactyl skulls were examined and an attempt was made to trace the probable course of evolution in this order of the otic region of the skull.

Thursday, June 16, 1927.

The Bakerian Lecture was delivered by Dr. F. W. Aston, F.R.S., on

A New Mass-Spectrograph and the Whole Number Rule.

By means of the first mass-spctrograph, built in 1919, the masses of all atoms, with the exception of hydrogen, were shown to be whole numbers on the oxygen scale, to one or two parts in 1,000. In order to measure their divergence a more powerful instrument was necessary. This has been made, with a resolving power of 1 in 600, more than sufficient to separate the mass lines of the isotopes of any known element, and with an accuracy of measurement as high as 1 in 10,000 when special methods of comparison are employed.

By means of this instrument the isotopic constitution of mercury has been decided, new isotopes discovered in sulphur and tin, and the two doubtful isotopes of xenon confirmed. 51 types of atom contained in 18 different elements, ranging from hydrogen to mercury, have been examined. Their masses and packing fractions, *i.e.*, their percentage divergence from the whole numbers expressed in parts per 10,000, are tabulated on the oxygen scale; e.g., the atom of phosphorus of mass number 31 has a packing fraction—5.6 + 1.5 and a mass 30.9825. The relations of tin and xenon have been re-examined and found not to show the striking abnormality previously suggested. The values for Li^6 and Li^7 are obtained by a re-calculation of Costa's results.

When the packing fractions of the atoms are plotted against their mass numbers, it is found that for all atoms above mass number 20, these lie roughly on a single curve. From mercury, packing fraction + 0.8, the curve descends to − 9 in the region of bromine. It then ascends and in the case of atoms of odd atomic number continues to do so, in a roughly hyperbolic manner, right up to hydrogen + 77.8. The light atoms of even atomic number have packing fractions well below this curve, and approximate to a branch rising much less steeply to helium + 5.4. This suggests that the light atoms of odd atomic number have a common loosely packed, and therefore heavy, outside structure, which is not present in the denser and more stable nuclei of helium, carbon and oxygen.

THE CHEMICAL SOCIETY.

Thursday, June 16.

Syntheses of Cyclic Compounds. Part I. Ethyl βγ - dimethylbutane - ααδδ - tetracarboxylate and Some Cyclo-*butane Compounds Derived Therefrom.* By H. Vogel.

Reduction of ethyl ethylidene malonate with moist aluminium amalgam yields ethyl βγ-dimethylbutane-ααδδ - tetracarboxylate, which on hydrolysis with alcoholic potash gives the two corresponding stereo-isomeric tetracarboxylic acids. When heated at 200° this yields the ββ′-dimethyladipic acids. Treatment of ethyl βγ-dimethylbutane-ααδδ-tetracarboxylate with sodium methoxide and bromine gives the *cyclo*butane compound, which on hydrolysis and heating to 180° affords the two stereo-isomeric βγ - diemthyl*cyclo*butane - αδ - dicarboxylic

The *cis* acid yielded an anhydride with acetyl chloride, while the *trans* acid yielded the *cis* anhydride with acetic anhydride.

A New Method of (Absolute) Potentiometric Titration. By B. Cavanagh.

A new and very simple method of "absolute" potentiometric titration, based on an application of Helmholtz's "concentration cell without liquid junction" is described. The requisite procedure in the titration of a strong acid, chloride, bromide, and iodide, is indicated. The sensitivity and accuracy are the highest obtainable by electrometric methods.

A silver halide electrode and platinum, dipping into a solution containing the corresponding halide ion, hydrogen ion, and a trace of quinhydrone, develop an *E.M.F.*

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY.

The Summer Evening Classes of this useful Institution began on 13 and 14 June. The curriculum covers a wide range of scientific and other subjects and the fees are moderate.

FRAUDULENT FERTILISERS.

The chemist of the Royal Agricultural Society of England reports as follows :—

"SOLUBILITY OF MINERAL PHOSPHATES.

Renewed attention has been drawn of late to claims put forward on behalf of certain proprietary fertilisers which, though sold under fancy names, are really little more than ground mineral phosphate.

The attempt is made to assign to them an availability and solubility approaching that of superphosphate, and superior to that possessed by basic slag and mineral phosphates generally.

This is done by stating the solubility of the material in a form not recognised by the Fertilisers and Feeding Stuffs Act, inasmuch as the guarantee is given as based upon the use of a quite different strength of citric acid solution, and under conditions as to quantities used, time occupied, etc., quite different from those laid down, and generally accepted, for basic slag, etc.

A sample of one of the above materials sent to me, and guaranteed to be of '95 per cent. solubility,' under the special conditions quoted, was found to be only 30 per cent. soluble when tested by the orthodox method.

It might be noted that in the New Fertilisers and Feeding Stuffs Act, which will shortly come into force, a guarantee in such misleading form is not recognised, but that the guarantee required will be simply the percentage of phosphoric acid and the fineness of grinding.

THE COAL PROBLEM.

Mr. Philip Gee, director of the Colliery Owners' Publicity Department, has issued the following statement on the proposals that persistently emerge from time to time from more or less responsible quarters for the "Rationalisation" or "Trustification" of the Coal Mining Industry.

1.—Is the object of trustification to produce more coal, or less? If it is to produce more coal, will not that aggravate the present alleged over-production? If it is to produce less coal, will not that aggravate the present unemployment and under-employment?

2.—Is the object of a selling agency—either national or internation—to sell coal at a higher price than it would be sold at under unrestricted competition?

3.—If so, is it probable that customers who are admittedly not buying enough of our coal at the present time would buy more of it if it were dearer

4.—If an international selling agency were in operation would it be probable that France, for instance, would be a party to that agreement, except upon such a basis as to relieve her collieries from competition by British coal? Similarly, would Germany submit to an agreement in respect of coal exports that would restore to us the position we held in 1913?

GERMAN SCIENCE.

A REVIEW OF SOME RECENT CHEMICAL BOOKS.

(*Continued from page* 383.)

(4) *Grundbegriffe der Kolloidchemie.* By DR. H. HANDOVSKY. Second Edition, pp. VI + 64. 1927. Price 2 marks 70 pf.

(5) *Aus Leben und Beruf.* By PROF. FRITZ HABER. Pp. VIII. + 173. 1927. Price 4 marks 80 pf. Both published by Springer, Berlin.

Like other of his publications, Prof. Handovsky's book on colloids deals more particularly with the applications of their study to biology and medicine and is intended for the use of biologists who must acquire a certain amount of knowledge in this field. For such it appears useful for it has passed into a second edition.

Prof. Haber's reflections are taken from essays, and lectures and follow on his recently published *Fünf Vorträge* (*The Chemical News*, 1924, CXXVIII., 338; May 24). They deal with Prof. Carl Engler's work, German chemistry during the past ten years, Impressions of Japan, Industrial connections between Germany and Japan, Science and the State, etc. Among the other subjects discussed is Prof. Haber's contribution to the controversy over the alleged synthesis of gold from mercury. With Drs. Jaenicke and Matthias he repeated the experiments of Nagaoka and Miethe, but with negative results

(6) *Spektroskopie und Kolorimetrie.* By DR. J. LIFSCHITZ. Second Edition, pp. 325, with tables. Leipzig: Verlag von Johann Ambrosius Barth. 1927. Price 25 marks.

This is the second edition of what was originally written by Prof. Baur in 1907 and is a part of the Handbook on Applied Physical Chemistry, edited by Prof. Bredig. It deals fully with the apparatus, the characterising and measurement of the lines, emission and absorption spectra (line and band), and with the technique of colorimetry.

(7) *Die Zerstaubungserscheinungen bei Metallen.* By ENGINEER J. FISCHER. Pp. 70. Berlin : Gebrüder Borntraeger. 1927. Price 4 marks 80 pf.

The conversion of metals into a pulverulent form has recently engaged the attention of metallurgists and metallurgical chemists. Dr. Fischer's monograph on the mechanical, thermal and electrical methods of obtaining metals in a finely divided form will be of interest to many.

(8) *Die Chemische Analyse.* By PROF. B. M. MARGOSCHES. Band XXV. Die Iodzahlschnellmethode und die Uberiodzahl der Fette. Pp. X + 227. Stuttgart : Ferdinand Enke. 1927. Price, 16 marks 20 pf.

The growth of analytical chemistry may be judged by the fact that this extensive volume (produced with the collaboration of Dr. L. Friedmann and Ing. L. Hermann-Wolf) is devoted to the determination of the Iodine-number of fatty substances. Analysts and others will find Prof. Margosches' compilations of value.

J. G. F. DRUCE.

NOTICES OF BOOKS.

Experimental Researches and Reports. Published by the Department of Glass Technology, The University of Sheffield. Vol. IX. 1926.

We have to thank Prof. W. E. S. Turner for a copy of this useful volume, which consists of 324 interesting pages, besides a number of plates. The volume contains over 20 papers, many of them by Prof. Turner, dealing with some phase of the glass industry. We have from time to time published in the *Chemical News* lengthy abstracts of most of the papers.

The Mechanics of the Atom. By MAX BURN, Professor in the University of Gottingen. Translated from the German by J. W. Fisher, B.Sc., Ph.D., and revised by Dr. R. Hartree, Ph.D. Pp. XVI + 318. Price 18s. net. London : G. Bell and Sons, Ltd.

Professor Born delivered a series of lectures at the Gottingen University in 1923-1924 under the title of "Atomic Mechanics" (Atcmmechanik) the title being chosen, we are told, to correspond with the designation "Celestial Mechanics," which covered the branch of theoretical astronomy which deals with the calculation of the orbits of celestial bodies according to mechanical law, while the phrase Atomic Mechanics, is chosen to signify that the facts of atomic physics are to be treated with special reference to the underlying mechanical principles. The Professor has in some respects gone beyond the bounds of demonstrated knowledge, but this will be deemed an advantage, as it is by speculations of this kind that the horizon of science is extended.

The author has written an interesting preface to the English edition in which there are only slight departures from the German text. The translator has done his work well and the result is a useful addition to existing scientific standard works, available for English readers Messrs. Bell, are now publishing a series of translations of continental scientific "classics" under the editorship of Prof. Andrade. This is the second volume in the series, which we hope will have the success it merits.

OFFICIAL PUBLICATIONS RECEIVED FROM THE U.S.A. BUREAU OF STANDARDS, WASHINGTON, D.C., U.S.A.

Effect of Eddy Currents in a Core Consisting of Circular Wires. Scientific Paper. 10 cents.

Linkage-Currents Diagram for Representing Magneto Operation. 10 cents.

The Lovibond Colour System : A Spectro-Photometric Analysis of the Lovibond Glasses. By K. S. Gibson and F. K. Harris. 15 cents.

Salt Bromine and Calcium Chloride in 1925. 5 cents.

The Bowie-Gavin Process ,Its Application to the Cracking of Tars and Heavy Oils, etc. 15 cents.

Relationship Between the Rockwell and Brinnell Numbers. 15 cents.

Tin in 1925. 5 cents.

Barite and Barium Products in 1925. 5 cents.

Lime in 1925. 5 cents.

Secondary Metals in 1925. 5 cents .

Gas Measuring Instruments. 40 cents.

U.S.A. Government Master Specification for Cement, Masonary.

Alphabetical Index and Numerical List of U.S.A. Master Specifications. Promulgated by the Federal Specifications Board. 10 cents.

Elimination of Waste, Simplified Practice. 5 cents.

Engine Service Tests of Internal Combustion Engine Lubricating Oils. 15 cents.

The Palouse Soil Problem, with an Account of Elephant Remains in Windborne Soil on the Columbia Plateau of Washington.

Surface Water Supply of the U.S.A., 1922. Part X. The Great Basin. Pp. 1,922.

Problems in the Firing of Refractories. 50 cents.

Sand and Gravel in 1925. 5 cents .

Safeguarding Workmen at Oil Derricks. 40 cents.

Explosibility of Coal Dust from Four Mines in Utah. 5 cents.

Silica in 1925. 5 cents.

Specification for Safety Matches.

VARIOUS.

Bulletin of the Institution of Mining and Metallurgy. April.—Among the contents are the Empire's tin resources, mining law in the Empire; notes on some ancient mining equipments; mica and its international relationships; the use of rubber in the mining industry.

Institution of Mining and Metallurgy Bulletin.—May.

School of Mines and Metallurgy, University of Missouri.—March, 1927, *Bulletin*, containing reports, facts and figures on the various useful activities of the above University. (Rolla, Missouri.)

Journal of the Department of Agriculture, Union of South Africa, Pretoria. Index to Vol XI.

Cheddar Cheese Making. By James P. Gow, Dairy Inspector, Natal (Government Printing Office, Pretoria).

Methods of Growing Large Metal Crystals. Being the fourth Sorby Lecture, delivered by Professor H. C. H. Carpenter, M.A. Royal School of Mines, London. 1s.

Directory of the Members of the Association of Tar Distillers. 166, Piccadilly, London, W.1.

Report of the Benzole Research Committee, 1927. (The National Benzole Association, Wellington House, Buckingham Gate, London, .SW.1.

This interesting Report represents co-operative effort for the purpose of research between representatives of a large and important British Industry, and those of a prominent University. Their last reports, and the report enclosed herewith is some indication of the success of their effort.

The nature of the work carried out, and the subject matter, is of special interest at the present time, for it represents an attempt at the application of systematic research to increase the supply of Benzole Motor Spirit produced in this country from coal. The work is well printed and handsomely bound.

Selenium: A List of References, 1817-1925. Compiled by Marion Foster Doty. The New York Public Library. Price 65 cents.

This book, of 114 pages, contains the titles of works (and a good deal of other information) dealing with Selenium between 1817 and 1925, with Index of Authors, Patentees and Subjects. It is a useful and authentic compilation.

Nitrate Facts and Figures, 1927. Compiled by A. F. Brodie James, F.S.S. 5s. net. London: Mathieson and Sons, Copthall Avenue.

Investigations on the Sugar Cane Disease Situation in 1925 *and* 1926. Louisana State University.

FORTHCOMING EVENTS.

THE INSTITUTION OF MINING ENGINEERS.

NOTICE OF GENERAL MEETING AT NEWCASTLE-UPON-TYNE, ON JUNE 29 AND 30, AND JULY 1, 1927.

The Eighty-sixth General Meeting of The Institution of Mining Engineers will be held at Newcastle-upon-Tyne on Wednesday, Thursday, and Friday, June 29th and 30th, and July 1st, 1927.

The Council of the North of England Institute of Mining and Mechanical Engineers have generously placed the House of the Institute at the disposal of the Institution as Headquarters during the meeting; and with their valuable assistance an instructive programme has been arranged.

Ladies are cordially invited to attend an Official Reception by the Lord Mayor of Newcastle-upon-Tyne on Thursday, June 30th, and to accompany members on the various excursions.

There will be an all-day Excursion to the Roman Wall on July 1st. Mr. Parker Brewis, F.S.A., has kindly consented to accompany and guide the party.

Members may have their correspondence addressed to the care of The North of England Institute of Mining and Mechanical Engineers, Neville Hall, Newcastle-upon-Tyne.

AGENDA-PROGRAMME.

Wednesday, June 29, at 10.30 a.m.—General Meeting in the Lecture Theatre of the North of England Institute of Mining and Mechanical Engineers, Neville Hall,

Newcastle-upon-Tyne. The Right Hon. The Lord Mayor of Newcastle-upon-Tyne and the President of the North of England Institute (Mr. A. M. Hedley) will welcome the Institution on behalf of the City of Newcastle-upon-Tyne and the Institute respectively.

The chair will be taken by the President, Dr. J. H. Haldane, F.R.S., and the following papers will be introduced and submitted for discussion :—

(1) "Notes on the Overhead Kœpe Winding Plant at the Murton Colliery of the South Hetton Coal Company, Limited." By George Raw, B.Sc.

(2) "The Cleaning of Coal by Means of Pneumatic Separators, with Special Reference to the Sutton Steele and Steele Process." By Kenelm C. Appleyard.

(3) "Experiments on the Reversal of Mine Ventilation." By W. D. Lloyd and J. N. Williamson, B.Sc., Ph.D.

(4) "An Attempt at the Rationale of Faulting and Subsidence." By Prof. Henry Briggs, D.Sc., Ph.D., A.R.S.M.; with an Appendix by John Morrow, MSc., D. Eng.

(5) "The Driving of Narrow Places." By S. Walton-Brown, B.Sc.

(6) "The Composition of Firedamp." By J. Ivon Graham, M.A., M.Sc., and A. Shaw, B.Sc.

The following papers, already published, will be submitted for further discussion :—

(a) "Miners' Nystagmus." By Freeland Fergus, M.D., LL.D.

(b) "Miners' Nystagmus." By J. S. Haldane, M.D., F.R.S., and T. Lister Llewellyn, M.D.

(c) "The Construction of Flame Safety-lamps." By R. V. Wheeler, D.Sc., and D. W. Woodhead.

Several interesting excursions have been arranged.

CORRESPONDENCE.

EXAMINATION QUESTIONS.

(To the Editor of the CHEMICAL NEWS.)

Sir,

I anticipated that you would publish further letters on the subject of Examination Questions as a result of Mr. Price's letter in your issue for May 27 (this vol., p. 334), under the title "Elementary Chemistry Teaching," for there must be many who will agree with him.

In the General School Examination of the London University, 1925, question 1 reads as follows :— "Given a supply of common salt, manganese dioxide, concentrated sulphuric acid and the ordinary laboratory apparatus, state what gases you would be able to prepare and give equations for the reactions involved."

How many gases do the examiners expect a candidate to mention to get full marks? I suppose HCl, Cl_2 and O_2 may be given without hesitation, but would it not be equally possible to make certain oxides of chlorine from those starting materials? Also, would "ordinary laboratory apparatus" include electrolysis apparatus, and if so should hydrogen also be included in the list?

The January 1924 London University Matriculation paper contains a question which might interest teachers of English. It includes the sentence :—

"What volume of a solution of sulphuric acid containing 32 grams per litre are required to *exactly neutralise* 5 litres of ammonia at 14° C., and 72 cm. pressure."

The italics are mine.

ANOTHER SCIENCE MASTER.

London, S.E.
June 11, 1927.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

14,748.—Hooley, L. J. Production of dyestuffs. June 1st.

14,504.—I. G. Fargenindustrie Akt.-Ges. —Production of dyestuffs. May 30th.

14,544.—Raw, G.—Chemical, etc. treatment of solid materials. May 30th.

14,641.—Still, C.—Recovering sulphuric acid. May 31st.

Specifications Published.

271,538.—Audibert, E.—Process for the production of substantially pure methanol.

271,580.—Du Pont Du Nemours & Co., E. L. — Water-insoluble colours or dyes.

253,488.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of azo dyestuffs.

257,900.—Soc. of Chemical Industry in Basle.—Manufacture of new compounds of gall acids.

271,725.—McKee, R. H.—Methods of making peroxides or organic acids.

Abstract Published.

Aryl derivatives of formamide are prepared by the interaction of carbon monoxide under pressure with a primary or secondary aromatic amine. The reaction may be effected at normal or elevated temperature, and a catalyst may be present. The catalysts comprise formic acid or its salts and esters, formamide or its derivatives such as formanilide, and alkali metals or their hydroxides and alkylates. Instead of carbon monoxide, gases containing it, such as water gas, may be employed. According to the example, carbon monoxide is forced under pressure of 200 atmospheres into an autoclave containing aniline together with a little methyl alcohol and metallic sodium, and the temperature maintained at 180-200° C. for some time; the product is worked up for formanilide. Other catalysts, such as metallic sodium or potassium, caustic soda, formanilide, methyl formate, ethyl formate or ammonium formate, may be employed. In the same way monoethylaniline may be converted into ethyl formanilide

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

LANAPOL

476,302.—Chemical substances in Class 1, for steeping, colouring and brightening textile fabrics and leather in course of manufacture, but not including coal tar colours.—H. Th. Bohme, Aktiengesellschaft, 29, Moritzstrasse, Chemnitz, Germany. June 8th.

STANIFORM.

479,512.—Chemical substances prepared for use in medicine and pharmacy.—Cornelius Victor Stephens, 73, Basinghall Street, London, E.C.2. June 8th.

BORETH.

480,238.—Chemical substances prepared for use in medicine and pharmacy.—Vernon Albert Edward Thomas, 6, Hope Street, West Richmond, near Melbourne, Victoria, Australia. June 8th.

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